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BIOLOGY 20

Human Homeostasis

Module 7



Distance
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Biology 20

Module 7

Human Homeostasis



**Distance
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Module 7
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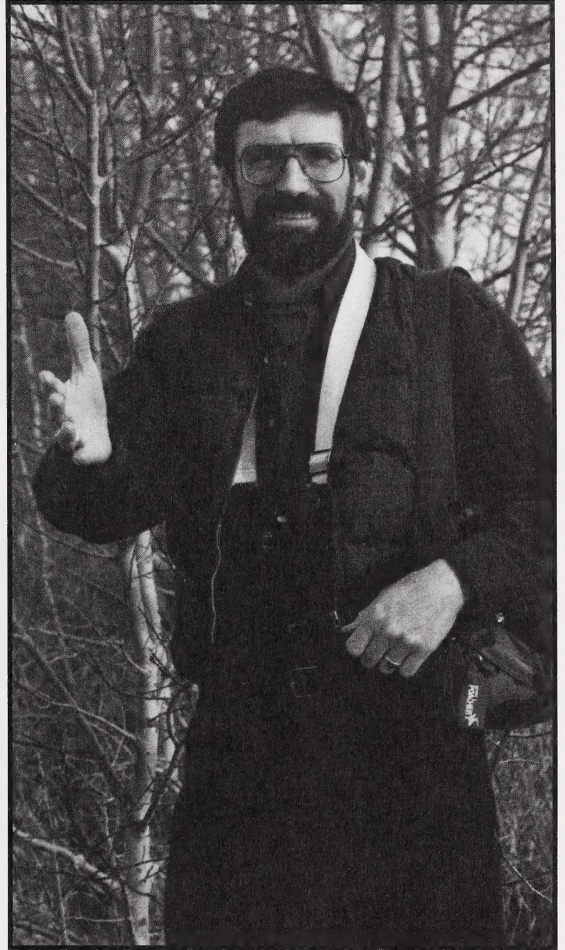
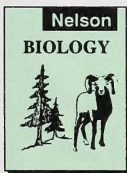
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Welcome to Module 7

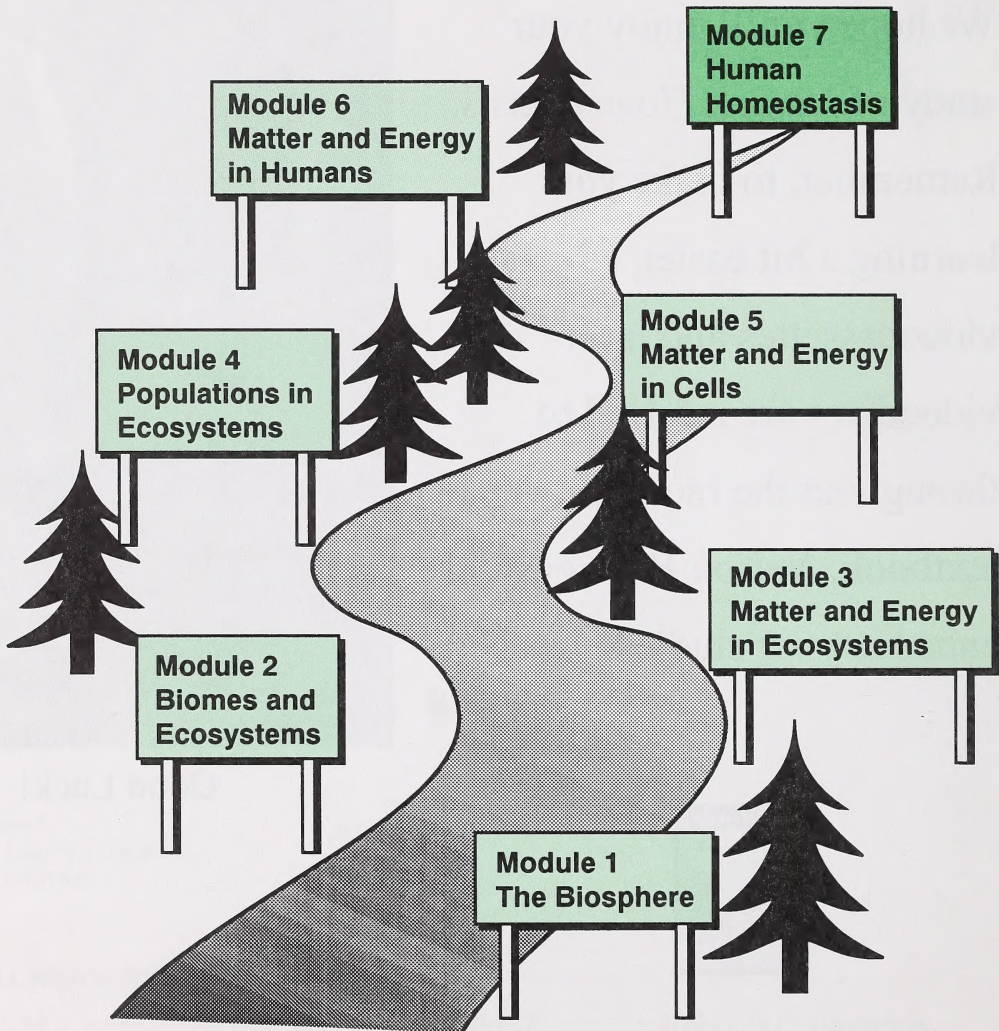
We hope you'll enjoy your study of *Human Homeostasis*. Remember, to make your learning a bit easier, several videocassettes and laser videodiscs are referred to throughout the modules. Your textbook, *Nelson Biology*, will enhance your studies.



Good Luck!

COURSE OVERVIEW

This course contains seven modules. The module you are working in is highlighted in a darker colour.



Contents

Module Overview	1
Evaluation	2
Section 1: Your Internal Plumbing	3
Activity 1: Circulation	4
Activity 2: Peripheral Circulation	7
Activity 3: Lubb-Dubb – The Beat of Life	10
Follow-up Activities	15
Extra Help	15
Enrichment	16
Conclusion	18
Assignment	18
Section 2: Your Lifestream	21
Activity 1: Blood Composition	22
Activity 2: Your Defence System	25
Activity 3: Severe Burns – A Case Study	28
Follow-up Activities	35
Extra Help	35
Enrichment	37
Conclusion	38
Assignment	38

MODULE

7

Contents

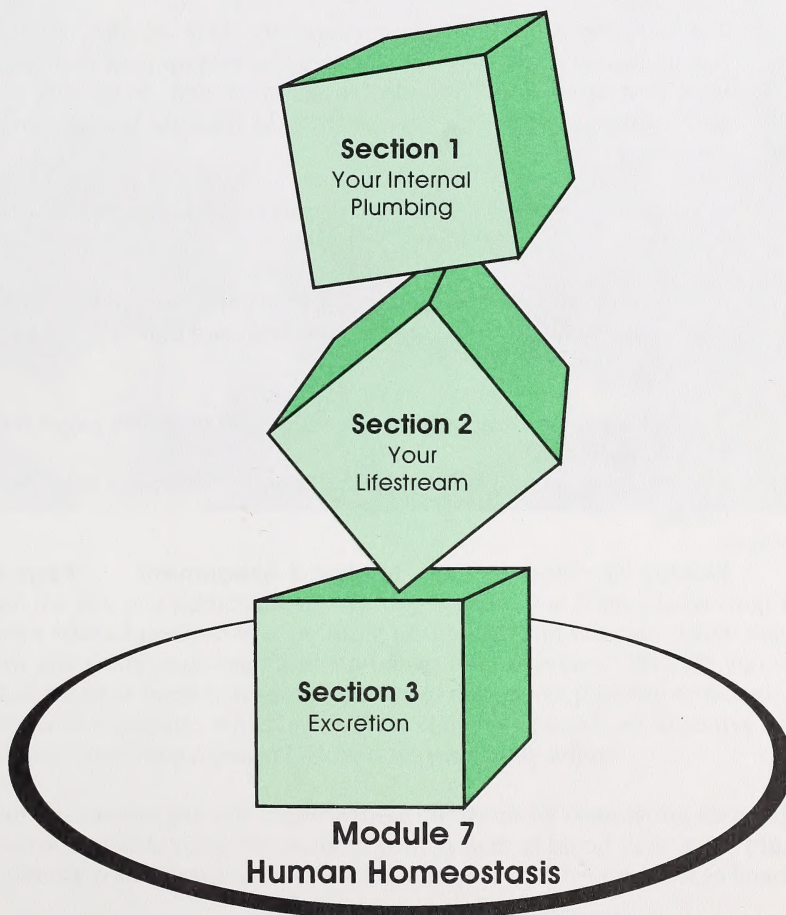
Continued

Section 3: Excretion	40
Activity 1: The Kidneys – A Balancing Act	41
Activity 2: Osmoregulation and Urine Formation	46
Activity 3: When Kidneys Fail	50
Follow-up Activities	54
Extra Help	54
Enrichment	56
Conclusion	56
Assignment	56
Module Summary	59
Appendix	61
Glossary	62
Suggested Answers	62

MODULE OVERVIEW

Have you ever spent a sleepless night worrying about your heart? Have you thought about whether your blood is winning the fight against intruding armies of bacteria and viruses? Probably not . . . there's too many other things to worry about, right? Yet daily your body is challenged with these concerns. Your cells are constantly screaming for food and oxygen and are demanding waste disposal as well as protection from invaders. It's amazing you can sleep at all!

The three sections of this module examine the structure and function of the specialized organs that make up the circulatory and excretory systems. These systems continually meet the challenge of maintaining a life-sustaining balance within your internal cellular environment.



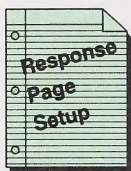
Evaluation

Your mark in this module will be determined by how well you complete the assignments at the end of each section. You must complete all assignments. In this module you are expected to complete three assignments. The mark distribution is as follows:

Section 1 Assignment	30 marks
Section 2 Assignment	30 marks
Section 3 Assignment	<u>40 marks</u>

TOTAL 100 marks

When doing your assignments, work slowly and carefully. If you are having difficulties, go back and review the appropriate section.



Read all parts of your assignment carefully. Plan and do your rough work on your own paper. Revise and edit your responses; then set up your final copy for submission on your own paper. Lined looseleaf is recommended. Make sure your answers are neat and organized, with wide left margins and space for teacher comments after each assignment.

When you see this icon, ideas and details are provided to help you set up and organize your answer in a certain way.

Before submitting your responses, be sure to proofread them carefully to ensure they say what you want, that they are neat and clear, and that they are complete and missing no material.

You will be submitting **only** your **assignment response pages** for evaluation.

It is important to number and clearly identify each page with this information placed at the top.

Biology 20 – Module 7 Section # Assignment Page # Name and ID #

Your Internal Plumbing



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Throughout the day you participate in a variety of activities. If the phone rings you can switch from a relaxed position to a sprinting position within seconds. Have you ever noticed how efficiently your heart accommodates new activities? Why do you suppose it's so critical for your heart to respond quickly to changes in physical exercise? What are the internal mechanisms which sense these changes? Does your digestive system change? Is your breathing affected? How does your body adjust?

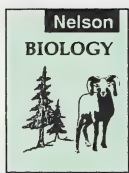
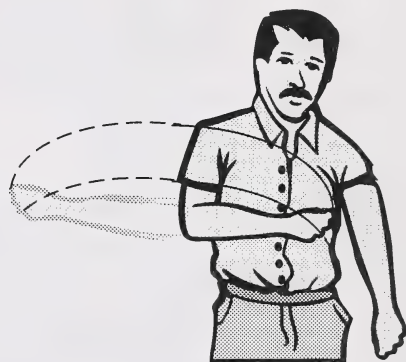
Throughout this section you will explore these questions by completing three activities. The first two activities involve the study of your system of blood vessels or "plumbing." The third activity concentrates on the heart and factors which contribute to heart disease.

ACTIVITY

1 Circulation

Inside your body an amazing system of blood vessels stretches for approximately 96 000 km. This is enough to stretch two and a half times around the Earth. Your heart, a muscle about the size of your fist, is responsible for pumping blood over that distance. It beats an average of 72 beats per minute which amounts to over 2.6 billion beats in a lifetime.

To really appreciate these numbers, take this challenge. Get out of your chair and stand for a minute. Are you ready? Extend one arm horizontally at chest height. Now bend your elbow and move your arm toward your chest. Watch the clock and do as many arm extensions as you can in one minute. Count only when your hand returns to your chest. You may be able to do over seventy in one minute, but how would you be at keeping up that pace for the rest of your life?



Read pages 244 to 252 in your text and complete the following questions. Some questions refer to text questions taken from the section entitled Review Questions on page 250 of your text. Answering these questions will help you gain an understanding of the heart and blood vessels.

1. Do textbook question 1.
2. Describe the role of the heart. Indicate the specific function of each side of the heart.
3. The major blood vessels in your body are the arteries, veins, and capillaries. Although they all carry blood through the body, they differ in structure and function. Construct and complete a chart similar to the following using pages 246 to 248 in your text. Note Figure 10.4 on page 247.

	STRUCTURE	FUNCTION
Arteries		
Veins		
Capillaries		

4. Do textbook question 4.

5. Explain how the disorder of varicose veins is related to vein structure and blood flow.

Check your answers by turning to the Appendix, Section 1: Activity 1.

PATHWAYS

If you have access to the video, *Respiratory and Circulatory System*, do Part A.
If you do not have access to this video, do Part B.

Part A

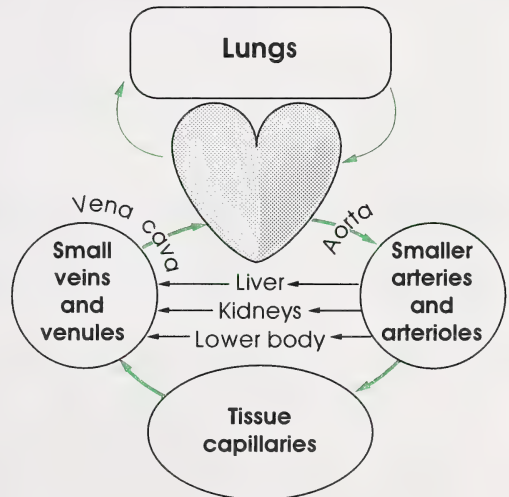
Like many systems in the body, the respiratory and circulatory systems work closely together. Watch the video *Respiratory and Circulatory System* and answer the following questions. As you watch the video, note the systemic and pulmonary circulation.



Science Skills

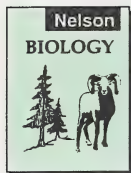
- ☐ A. Initiating
- ☐ B. Collecting
- ☐ C. Organizing
- ☐ D. Analysing
- ☒ E. Synthesizing
- ☐ F. Evaluating

6. How does blood entering the right side of the heart differ from blood entering the left side?
7. Describe the interrelationship that exists between the respiratory and circulatory systems.
8. Use the video definition to circle the sections of the diagram which represent the systemic and pulmonary circuits. Label the circuits.



The following diagram represents the pathway of a red blood cell (RBC) as it travels through these two circuits. This trip takes only twenty-four seconds.

Part B

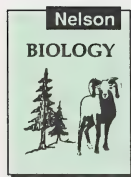
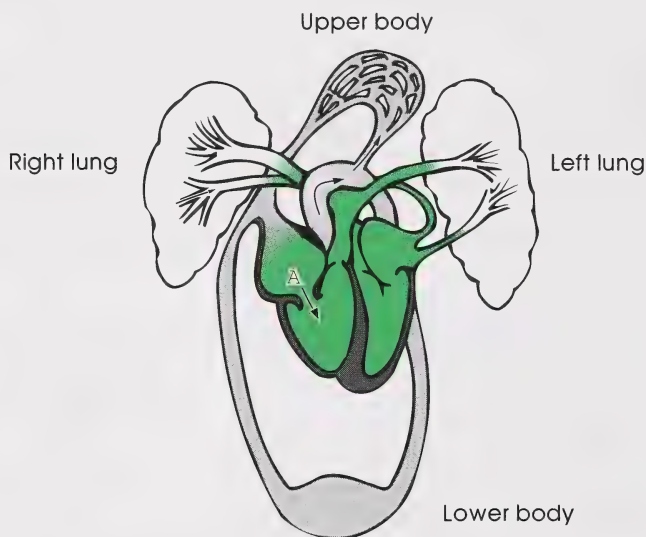


Read the section entitled The Heart on page 252 of your text and answer questions 6, 7, and 8 from Part A.

By now you should have the impression that the heart is really a double pump supporting two circulatory systems. Of course, these systems are connected so that blood flows continually through each of them. Can you appreciate the serious consequences of a leak?

Use Figure 10.9 on page 252 of your text for this next question.

9. On this sketch of the heart indicate the blood flow with arrows. Start at A and continue until you come back to A.



10. Using Figure 10.9 on page 252, Figure 10.11 on page 253 of your text, and the diagram you just completed, name the major structures that the blood passes through from the time it enters the main aorta to the time it returns to the main aorta. Notice that on most diagrams the main aorta passes over and down behind the heart.

Start with the main aorta and choose structures from the following list in the correct order.

- | | | | |
|----------------|---------------|--------------------|------------------|
| • main aorta | • arteries | • pulmonary vein | • left ventricle |
| • right atrium | • capillaries | • pulmonary artery | • vena cava |
| • left atrium | • lungs | • right ventricle | • veins |

Check your answers by turning to the Appendix, Section 1: Activity 1.

ACTIVITY

2

Peripheral Circulation



Think back to the coldest day last winter. Were your fingers and toes freezing? Now think about the hottest day last summer. Were you sweating from every pore in your body? Conditions like these challenge your circulatory system. Cold or hot on the outside of your body must not cause changes on the inside. Your peripheral circulation adjusts to protect you. This activity investigates some responses.

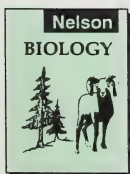
Investigation: Temperature and Peripheral Circulation

Objective

The objective of this investigation is to study changes in temperature and peripheral circulation.

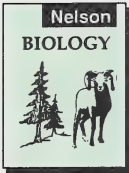
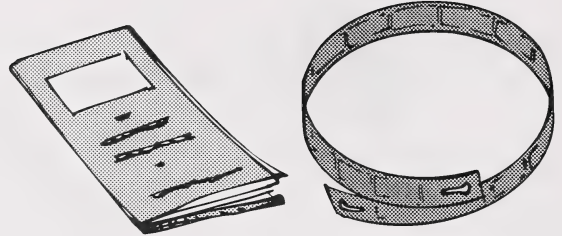
Background Information

Peripheral circulation refers to blood flow outside the body core such as in the arms, legs, or skin. This circulation carries heat away from the body core. Normal body core temperature is about 37°C . As heat is exchanged with the environment, peripheral temperatures may vary from the core temperature. Read the Background Information in the laboratory on page 251 in your text for an introduction to liquid crystal technology. In this investigation you will use a calibrated liquid crystal strip to study temperatures in various body areas.



Materials

- liquid crystal strip thermometer
- elastic strap
- instruction guide
- access to a mirror*



*supplied by student

Procedure and Observations

Remove the strip thermometer from the package and place it on the desk beside you. Read through the instruction guide, paying particular attention to the *Care of Thermometer* section.

1. Each liquid crystal indicates a temperature. How many liquid crystals are on the strip?
2. Fractions of degrees are indicated by specific colours. How long must a crystal remain illuminated to indicate an exact temperature?
3. What temperature is indicated by orange-brown?
4. What temperature is indicated by green-blue?
5. What colour indicates that the next degree is almost reached?
6. Look at the strip thermometer beside you. What temperature is it indicating? This is quite close to room temperature.

Gently bend the strip thermometer across the back of one hand so that the 20° to 26° temperatures are visible. Make sure the thermometer is in actual contact with your skin.



7. Do any temperatures light up? Now slide the strip thermometer across the back of your hand so that the 28° to 35° section is in contact. Remember to wait ten seconds for the temperature to change completely.
8. What temperature is the back of your hand?

Science Skills

- ☐ A. Initiating
- ☒ B. Collecting
- ☐ C. Organizing
- ☐ D. Analysing
- ☐ E. Synthesizing
- ☐ F. Evaluating

9. Predict whether the temperature of your upper arm would be higher or lower than the back of your hand. Why? Wrap the thermometer around your upper arm and observe the temperature.

You now have enough experience to predict the temperature of your forehead.

10. Predict the temperature of your forehead. Measure the temperature of your forehead as shown in the instruction guide for the thermometer.

Analysis and Interpretation

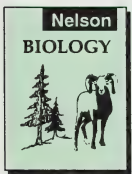
11. If your body core temperature is about 37°C , why would the temperatures of the various areas you measured be different?
12. If the body core temperature increased, for example during a fever, how might the temperature of the peripheral circulation respond? Muscles in the walls of the arterioles can expand or contract, changing the diameter of the arterioles and the volume of blood flow.

Science Skills

- ☐ A. Initiating
- ☐ B. Collecting
- ☐ C. Organizing
- ☐ D. Analysing
- ☒ E. Synthesizing
- ☐ F. Evaluating

13. a. How might the diameter of the arterioles be changed in response to a fever where core temperatures are increasing?
- b. How would this help maintain homeostasis?
14. How might the diameter of the arterioles change, in such a way as to prevent heat loss by the body core, in response to your legs being immersed in cold water?

15. Using your knowledge of peripheral circulation, speculate how peripheral circulation may be related to hypothermia. You can review hypothermia on pages 83 and 90 in your text. You might try the strip thermometer across your chest or around a large muscle group like your upper or lower leg. Carefully place the strip thermometer back in the package along with the instruction guide and elastic strap.



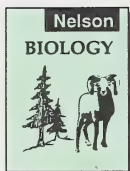
Check your answers by turning to the Appendix, Section 1: Activity 2.

Changes in capillary blood flow indicate much more than anger, embarrassment, or fear. Medical technology uses changes in circulation in the diagnosis of many health conditions. Some forms of cancer can be detected by changes in blood flow. Some cancerous tumors actually stimulate increased blood vessel development to increase circulation to meet their needs.

ACTIVITY

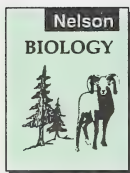
3 Lubb-Dubb – The Beat of Life

The last two activities concentrated on blood vessels. In this activity you will explore the tireless pump – the heart. You will be taking your pulse and learning about blood pressure and prevention of heart disease.



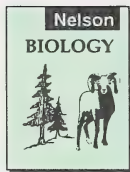
In order to gain some background knowledge on the pathway of blood flow in your body, review One-Way Blood Flow on pages 252 to 254 in your text.

1. What structures ensure that blood only flows in one direction through the heart?
2. What blood vessels supply blood to the heart itself?



Your pulse is a good indicator of your heartbeat, but heart sounds are also important indicators of proper function and heart health. Read more about heart sounds on pages 258 to 259 in your text and answer these next questions.

3. a. What causes the lubb-dubb sounds?
- b. Many children are born with defective heart valves. This condition, referred to as a “heart murmur,” can be heard using a stethoscope. What circulatory problems could be indicated by a heart murmur?



Two other important concepts you need to know about are cardiac output and blood pressure. Read pages 259 to 262 of your text to learn more about how your circulatory system functions. Then answer the next questions.

4. Generally the left side of the heart seems much larger than the right side. Examine Figure 10.12 on page 254 and Figure 10.15 on page 255 of your text. If cardiac output is equal on either side, describe why there is a difference in the size of the ventricles.
5. What two factors are used to determine cardiac output?
6. Explain how cardiac output relates to physical fitness.
7. Examine the cardiac output for Tom and Lee on page 259 of your text. Which individual is likely in better physical condition? Explain why you think so.
8. If a totally inactive person decided to participate in a aerobic fitness show on television, how would the cardiac output be affected?

Science Skills

- ☐ A. Initiating
- ☐ B. Collecting
- ☐ C. Organizing
- ☒ D. Analysing
- ☒ E. Synthesizing
- ☐ F. Evaluating

Check your answers by turning to the Appendix, Section 1: Activity 3.

Investigation: Pulse Rate

Caution

Caution! If you are a smoker do not complete this investigation unless at least one hour has elapsed after your last cigarette.

Objective

Record changes in pulse rate during exercise.

Science Skills

- ☐ A. Initiating
- ☒ B. Collecting
- ☐ C. Organizing
- ☒ D. Analysing
- ☐ E. Synthesizing
- ☐ F. Evaluating

Background Information

Your pulse rate can be used to indicate your level of fitness. An average resting pulse rate is seventy to one-hundred beats per minute. Long-distance runners can have a resting pulse rate as low as forty beats per minute.

Recovery rate is also a sign of fitness. This is the time required for the heart rate to return to normal after vigorous exercise. Better physical condition is indicated by short recovery time.

Caution

Caution! After five to ten minutes of an aerobic exercise, your pulse should not exceed two-hundred beats per minute minus your age ($200 - \text{age} = \text{maximum pulse rate}$). If this rate is exceeded, slow your workout down. For example, $200 - 18 = 182$. One-hundred and eighty-two is your maximum safe heart rate.

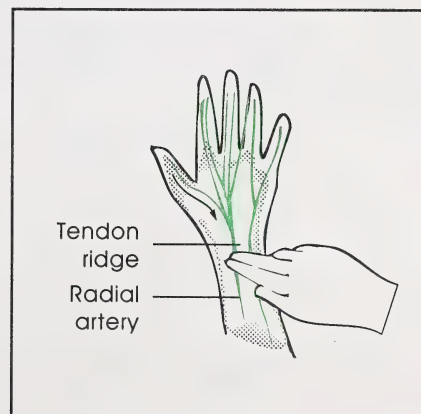
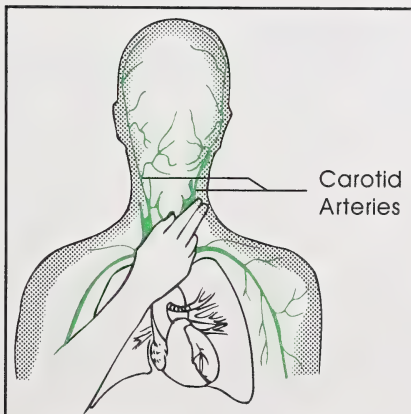
Materials

- watch or clock with second hand
- access to stairway
- calculator

Procedure

Using your index and middle finger side by side, take your resting pulse rate for fifteen seconds at either of the following locations:

- side of your neck (carotid artery)
- inside of your wrist (radial artery)



Multiply the fifteen-second pulse rate by four to obtain your resting heart rate per minute. Repeat the exercise five times. Record the results each time. Take the average of the five trials (total of all pulse rates divided by five).

Step Test

Science Skills

☐ A. Initiating

☒ B. Collecting

☒ C. Organizing

☒ D. Analysing

☐ E. Synthesizing

☐ F. Evaluating

Now that you have an estimate of your resting heart rate, you're ready for a step test. In this test you'll perform a physical activity designed to raise your heart rate; then you will record your highest pulse. Next you'll stop the activity and monitor your heart rate as it returns to normal.

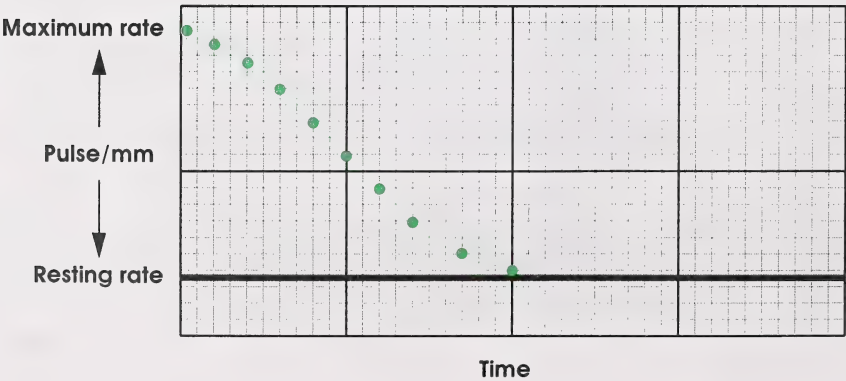
Set up a data table that will accommodate ten minutes with entries every thirty seconds. Here's an example:

TIME	BEATS PER 15 s	BEATS PER MINUTE
0 (resting)		
0.5 (maximum)		
1.0		
1.5		
2.0		
2.5		

- When you're ready, move to a set of stairs.
- Record your resting pulse rate.
- Briskly step up two steps and down two steps for one minute.
- Stop. Count your pulse for fifteen seconds and record the number on the table.
- Measure and record your pulse every thirty seconds for ten minutes.
- Convert the fifteen-second pulse to beats per minute.

Interpretation

- Transfer your data to a graph.
- Draw a horizontal line at your resting rate.
- Draw a second line to show the recovery rate after exercise as in the example.



9. Calculate the maximum exercising heart rate for your age ($200 - \text{age}$). Did you exceed this rate during your step test? If your answer is yes, this exercise is too strenuous. Exercise at a slower pace and try to work up to this level in the future.
10. For endurance training, a heart rate should be sustained between 75% and 85% of your maximum level. This is called the heart rate target zone. Calculate your target zone range.
11. Why is it essential for your heart rate to increase during exercise?
12. In this investigation you took your pulse for a total of five trials. Why didn't you just use one trial to find your resting heart rate?
13. Explain why the resting heart rate gives you a rough idea of your general fitness level.
14. Would you expect your resting heart rate to increase, decrease, or stay the same after three weeks of a strenuous exercise program? Explain your answer.
15. Did the step test cause any other changes in your body functions? Describe any changes you observed and try to explain why they occurred.

Check your answers by turning to the Appendix, Section 1: Activity 3.

Blood Pressure

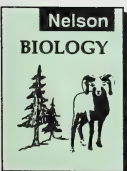
Fact: The life expectancy of a 35-year-old with slight hypertension (high blood pressure) may be reduced from 73 to 55 years.

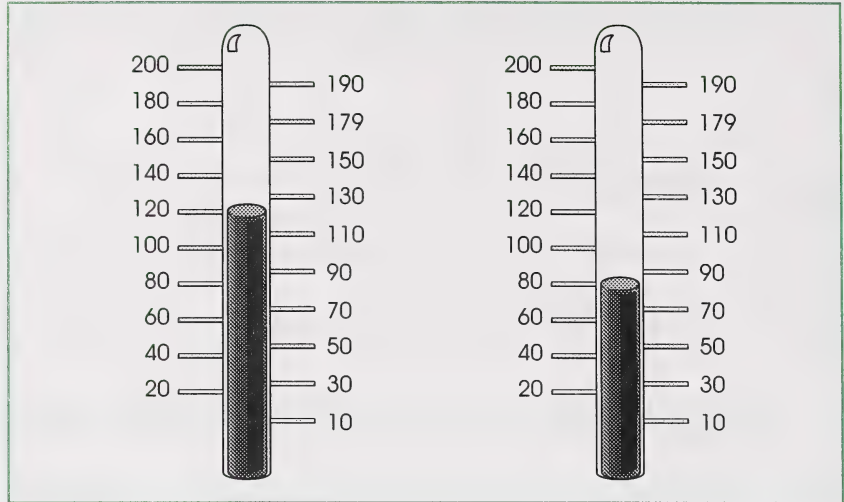
Alberta Stroke and Heart Foundation statistic

Do you know anyone with high blood pressure? How old are they? Blood pressure is necessary to move blood through the blood vessels and through many organs of the body such as the kidneys and liver. But too little or too much blood pressure can be harmful.

Read about blood pressure on pages 260 to 262 in your text and answer the following questions.

16. Describe the differences between systolic and diastolic blood pressure.
17. Why is high blood pressure (hypertension) dangerous to your health?
18. What would your blood pressure be if your doctor recorded the following readings on a mercury sphygmomanometer?





Check your answers by turning to the Appendix, Section 1: Activity 3.

The Road to a Healthy Heart

Statistics from 1988 indicated that 43% of all deaths in Canada were the result of heart disease. In Alberta alone, 3 962 people died of heart disease in the same year. Have you any idea whether you are at risk of dying from heart disease? What can be done to minimize the risk? The following video will help you answer these questions and might put you on the road to attaining a healthier heart.

PATHWAYS

If you have access to the video, *Healthy Choices, Healthy Hearts*, do Part A.
If you do have access to this video, do Part B.

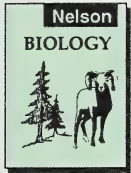
Part A



View the video *Healthy Choices, Healthy Hearts* and answer the following question.

19. The risk factors that have been identified in the video increase the risk of heart disease. Based on these risk factors, what habits would you retain in your lifestyle and what could you change to minimize your risk of dying from heart disease?

Part B



Read the Social Issue on page 267 in your text. List the risk factors related to heart disease and briefly describe how you could change these factors in your lifestyle.

Remember in the case of heart disease, risks don't add up; they multiply!

Check your answers in the Appendix, Section 1: Activity 3.

Follow-up Activities

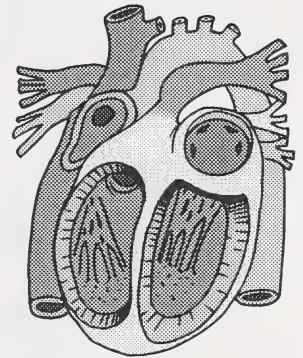
If you had difficulties understanding the concepts in the activities, it is recommended that you do the Extra Help. If you have a clear understanding of the concepts, it is recommended that you do the Enrichment.

Extra Help

- Using information from your text and the following terms, fill in the blanks in this paragraph.

The heart is a special pump. It consists of _____ chambers – two small upper _____ and two large _____. The _____ ventricle delivers blood to the lungs and the _____ ventricle delivers blood to the entire body. The _____ in the heart prevent the backflow of blood into the chambers.

_____ are thickly walled and carry blood _____ the heart. Veins are _____. Special one-way valves ensure blood moves _____ the heart when squeezed by surrounding muscles. _____ are microscopic blood vessels with walls that are only _____ cell thick. Through the thin capillary walls oxygen and nutrients diffuse to the body cells.



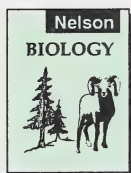
These are suggested terms; not all terms are needed.

- | | | | | |
|---------|-----------------|---------------|--------------|------------------|
| • one | • toward | • capillaries | • four | • thickly walled |
| • two | • away from | • right | • atria | • veins |
| • three | • thinly walled | • left | • ventricles | • arteries |

2. Match the following terms with the correct statement:

- artery • vein • capillary

- _____ a. This directs oxygen-rich blood to body cells.
 _____ b. Diffusion of nutrients and oxygen to body cells occurs here.
 _____ c. This produces a pulse in response to the heartbeat.
 _____ d. This contains one-way valves which allow blood to flow only one way.



3. Use information on pages 252 and 253 and Figure 10.11 in your text to help you match these structures and functions.

Structures	Functions
a. septum	i. carries blood to lungs
b. right atrium	ii. is the valve between left atrium and ventricle
c. atrioventricular valve	iii. carries blood out to body
d. semilunar valve	iv. receives blood from lungs
e. pulmonary artery	v. receives blood from body
f. left atrium	vi. is the muscle between ventricles
g. main aorta	vii. is the valve before main aorta

Check your answers by turning to the Appendix, Section 1: Extra Help.

Enrichment

- Ask for the loan of a stethoscope from either your school's science department or from a local clinic. When using a stethoscope, apply it firmly to the area over your heart but don't press hard.
 - Place the stethoscope in the left-centre region of your chest. How many distinct sounds make up a heartbeat? Listen to the heartbeat of your pet if you have one.

- b. Test the pulse areas of the carotid and radial arteries. Can you hear the heartbeat? Why do you suppose it is possible to hear blood in the artery when your blood pressure is being taken? (Next time you are in the doctor's office ask if you can hear the blood pressure sounds).
 - c. Tilt your head back and place the stethoscope in the hollow of your throat. Listen as you hum, swallow, and breathe deeply several times. What do you hear?
 - d. Ask a friend wearing a blouse or shirt made of thin material to volunteer to be your subject. Place the stethoscope between the lower portion of their shoulder blade (scapula) and backbone. Have the person breathe deeply several times as you listen to the sound of air entering their lungs. Move the stethoscope around their upper back region to determine the area occupied by the lungs.
 - e. After eating a snack, lie on the couch. Hold the stethoscope to your stomach and listen to the sounds. Now try your intestines. What do you hear?
 - f. Hold the stethoscope along the side of your lower jaw. Open and close your mouth and clench your teeth. Describe the sound produced as a result of the contracting muscles.
2. The heartbeat of small rodents and birds can be as high as 400 beats per minute. Research why this is necessary. Also look up what happens to the heartbeat when an animal hibernates.
 3. Alberta winters can be fatal if you are stranded in a vehicle without adequate survival gear. Sadly, each winter the cold weather claims victims who have died of hypothermia (lowered body core temperature). Write to the Red Cross Society and ask for information about hypothermia. You can use this address:

Canadian Red Cross Society
9931-106 St.
Edmonton, Alberta
T5K 1E2
 4. Research how thermography is used to detect cancerous tumors. One source of information could be a health clinic near where you live.
 5. In the spring, exploring children may sometimes venture out on thin ice and break through. Research why some of these children survive after being submerged up to forty minutes when normally brain death will occur within three to four minutes.

Why not challenge yourself to a twenty-minute fitness program four times a week in which you sustain your endurance heart rate for ten minutes? Use five minutes for warm up and five minutes for cool down. You can redo the step test monthly to determine if you have improved your recovery rate. A fitness program can be as simple as a ten-minute walk or as complex as playing hockey. Find some exercise you like doing that is good for fitness at the same time.

For more information on fitness write to the Heart and Stroke Foundation of Alberta and ask for these pamphlets:

- Walking for Fun and Fitness
- The Joy of Jogging

The Heart and Stroke Foundation of Alberta
10985-124 Street
Edmonton Alberta T5M 0M9

or

1825 Park Road S.E.
Calgary, Alberta
T2G 3Y6

Check your answers by turning to the Appendix, Section 1: Enrichment.

Conclusion

As you have discovered throughout this section, the daily activities in which you so casually participate must be monitored closely by your cardiovascular system. The adjustments made by this system in the efficient transport of blood contributes to your internal homeostasis. In the next section you will explore the role played by blood itself in the continual quest for internal stability.

30

Section 1 Assignment: Your Internal Plumbing

Review the Evaluation information found in the introductory pages of this module.

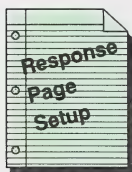
It is important to number and clearly identify each page with the following information at the top:

Biology 20 – Module 7 Section 1 Assignment Page # Name and ID#

Be sure to write legibly. Leave a wide left margin and number all of your pages.

- Briefly describe the function of the digestive, circulatory, respiratory, and excretory systems in supplying matter and energy to body cells and in removing wastes. Show how they work together. (10 marks)

Reproduce the science skills assessment box after your response to this question. Remember to indicate your evaluation of your skill level for each identified science skill. Be sure to include the spaces for teacher assessment.



Science Skills	
☐	A. Initiating
☐	B. Collecting
☒	C. Organizing
☐	D. Analysing
☒	E. Synthesizing
☐	F. Evaluating

Self: A.	☐	B.	☐	C.	☐	D.	☐	E.	☐	F.	☐
Teacher: A.	☐	B.	☐	C.	☐	D.	☐	E.	☐	F.	☐

- It's a well-known fact that fingers and toes are the first parts of the body to suffer from frostbite. Explain why the homeostatic mechanism of decreasing peripheral blood flow is critical to survival. **(5 marks)**
- The following scenario might be all too familiar:

Without paying too much attention, you and a friend eat an entire box of chocolates while watching a great movie. The next morning you look in the mirror and it's ... acne! Off you go to the medicentre; your doctor comes to the rescue with an oral prescription which should clear up the acne in a few days. The instructions are to swallow the pills with food.

Use your knowledge of the interrelationship that exists between the digestive and circulatory systems to describe the pathway of the drug to its desired destination. Describe the total sequence of organs the drug will pass through. **(5 marks)**

- Identify the circulatory problem and symptoms which would result if a child was born with an incomplete A/V valve between the left atrium and the left ventricle? **(2 marks)**

Reproduce the science skills assessment box after your response to this question.

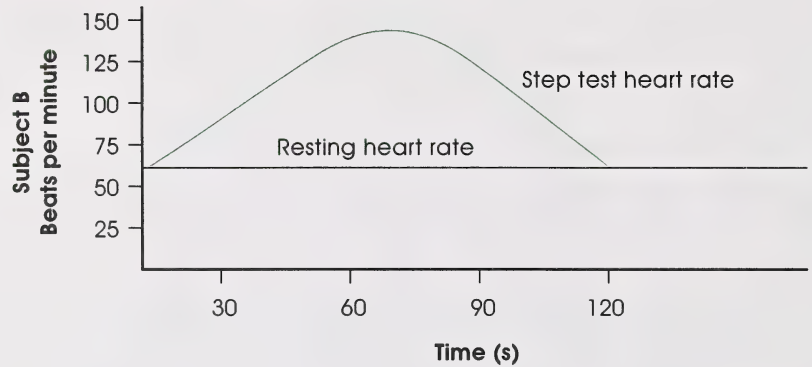
Remember to indicate your evaluation of your skill level for each identified science skill. Be sure to include the spaces for teacher assessment.

Self:	A. ☐	B. ☐	C. ☐	D. ☐	E. ☐	F. ☐
Teacher:	A. ☐	B. ☐	C. ☐	D. ☐	E. ☐	F. ☐

- Based on the information provided in the graph, determine which of the individuals probably does not exercise regularly. Explain your choice. **(3 marks)**

Two subjects partake in a step test completing thirty step-ups in one minute.





6. Bill Dunn has just been told by his doctor that he has high blood pressure. List three things that Bill could do to reduce his blood pressure and explain how each could help lower his blood pressure. **(5 marks)**

Your Lifestream



PHOTO SEARCH LTD.

pathogen –
microorganism
that can cause
disease

As you live through each day you are exposed to hundreds of different **pathogens**, yet rarely do you get sick. When you fall and cut yourself, you're seldom in danger of bleeding to death. What is the role of the blood in combating these daily challenges? How would a traumatic event such as a severe burn impact the functioning of your circulatory system?

Throughout this section the role of blood in maintaining health will be explored. The components of your living fluid are examined in the first activity. The second activity stresses the immune response and discusses the use of vaccines to assist your immune system. The third activity presents a case study in which a person has suffered a severe burn. The impact such an accident has on maintaining internal homeostasis is analysed.

ACTIVITY

1 Blood Composition

homogeneous – consisting of the same components throughout

Think back to your last nosebleed; it's easy to understand that without a microscope, blood appears to be a **homogeneous** fluid. Only with the invention of the microscope was it revealed that the red liquid coursing through your veins was actually a loose tissue consisting of different cells. In the past the function of blood was so much in doubt that many ancient treatments for disease involved blood letting. Huge black leeches were placed at various locations on the patient's body to rid the body of the evil spirits thought to be present in blood that caused the illness. In this case, being nostalgic for the good old days might not be in your best interest!

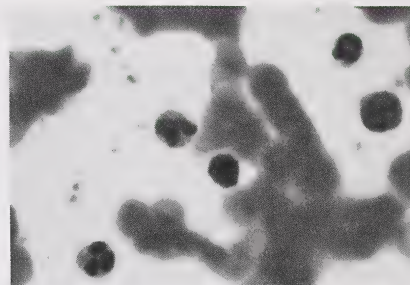
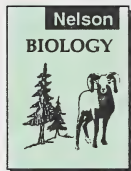


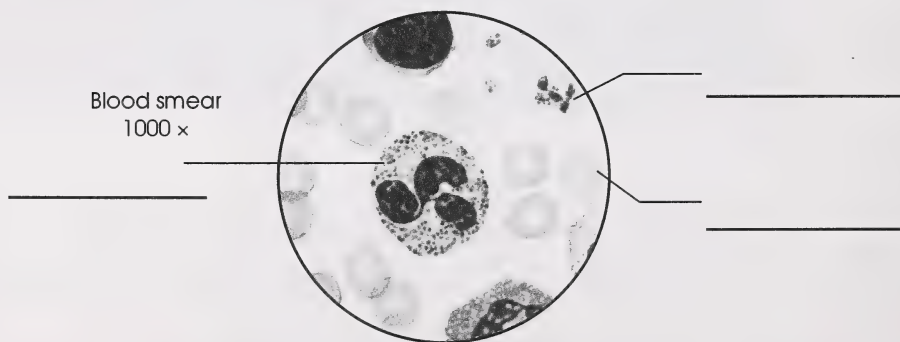
PHOTO SEARCH LTD.



To introduce you to blood components, read pages 270 to 274 in your text. Use the information to complete the questions that follow.

You will recall that information on blood cells was included in the video *The Circulatory and Respiratory System*, which you may have viewed in the last section. You may want to review the last half of the video at this point to help you complete the questions.

1. Write a brief description of the function of each of the following cell types. Include any other special features. Find and label the cell type in the following diagram. You may wish to use Figure 11.6 on page 274 in your text.



- a. Red blood cells (RBCs/erythrocytes)
- b. White blood cells (leucocytes)
- c. Platelets (thrombocytes)

2. What percentage of the blood is plasma? Describe the composition of plasma.
3. White blood cells have a nucleus; whereas red blood cells do not. What is the significance of red blood cells not having a nucleus?
4. Sam has been feeling really tired lately and looks quite pale. He eventually goes to the doctor. The results of his blood test indicate he is anemic. How can a blood test indicate that he has anemia? Relate these findings to his symptoms in your answer.
5. What is the stimulus that increases RBC production and how does this demonstrate homeostasis?
6. Where are all blood cells produced?

Check your answers by turning to the Appendix, Section 2: Activity 1.

Investigation: Looking at Blood

Objective

The purpose of this investigation is to identify blood cell components.

Background Information

Read the background information that accompanies each microslide.

Materials

- microslide viewer
- microslides – set 95, Human Blood

Procedure

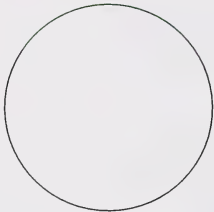
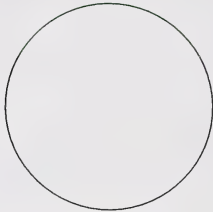
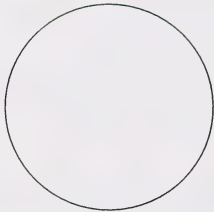
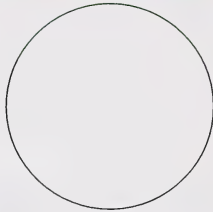
- Follow the instructions as outlined in the background information to load your slides.
- View Slide 1. On your observation sheet draw a platelet, two red blood cells, and one of each type of white blood cell as indicated in the slide. Record their magnification.
- View Slide 2 – Electromicrograph. Draw two red blood cells (RBCs) at this high magnification showing their biconcave shape. Record their magnification.
- View Slide 3 – Light Micrograph. Note the appearance of the different types of white blood cells (leukocytes). Sketch two cells including the distinctive shape of each cell's nucleus.

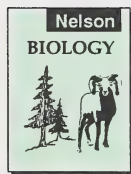
Science Skills

- ☐ A. Initiating
- ☒ B. Collecting
- ☐ C. Organizing
- ☐ D. Analysing
- ☐ E. Synthesizing
- ☐ F. Evaluating



- View Slide 4 – Electromicrograph. Draw the phagocytotic action of the leukocyte in the right half of the slide as it extends its pseudopodia into the body tissue. Record the magnification.
- View Slide 7 – Sickie Cells. Draw the appearance of three abnormal sickle red blood cells.

OBSERVATIONS	
Slide 1 – Human Blood Smear  magnification –	Slide 2 – Red Blood Corpuscles  magnification –
Slide 4 – Phagocytosis  magnification –	Slide 7 – Sickie Red Blood Cells  magnification –



You can check your diagrams by looking at the figures on pages 272 and 274 of your text.

Analysis and Interpretation

- From examining the blood smear in Slide 1, which blood cell is in the highest proportion in blood?
- What is the advantage of the RBC having a biconcave shape?

Application

- Anemia is a condition resulting from a low red blood cell (RBC) count or inadequate amounts of hemoglobin.
 - What symptoms would be typical of a person who is anemic? Explain.

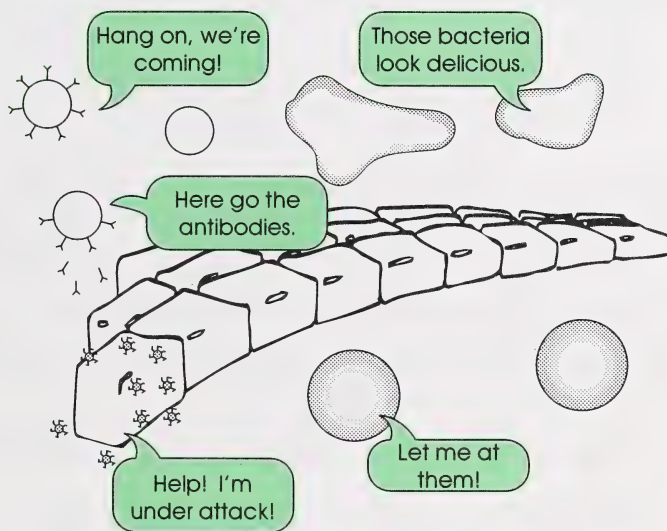
- b. If an individual with a low RBC count moves to a high altitude, their red blood cell count improves and they begin to feel better. Explain why a person's RBC count would increase at high altitudes.

As you can now see, your blood is not a simple red liquid – it is a complex fluid containing cells and many dissolved substances.

Check your answers by turning to the Appendix, Section 2: Activity 1.

ACTIVITY

2 Your Defence System

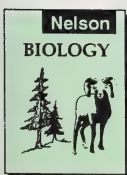


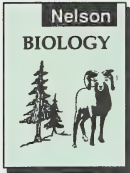
Every day your body is under attack by hundreds of viruses and bacteria. As a result, your blood mobilizes an incredible army into action. This activity will help you understand the complex events which spring the immune system into action.

The Lymphatic System

Before you can learn how your immune system works, you need to know about your lymphatic system. Read about it on page 266 of your text; then answer the next two questions.

1. What is lymph and why is it transported in a specialized system?



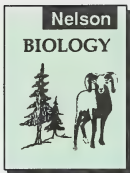


Lymph is returned by the lymphatic system to the blood vessels at each shoulder vein. Refer to the diagram on page 266 of your text.

2. What are lymph nodes? Describe their function.

Swollen glands are actually enlarged lymph nodes. They indicate that your immune system is hard at work combating an infection.

Under Attack



Have you ever been scratched by a cat or stung by nettles? How about being bitten by a mosquito or worse . . . stung by a bee? This isn't fun – but it's hard to get through life without these experiences. In all these cases, your body responds instantly. The swelling, pain, and redness are all part of an immune response. Read Immune Response on pages 280 to 283 in your text and answer the following questions.

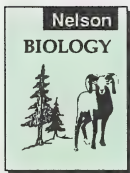
3. What is the body's first line of defence against intruding pathogens?

The body's second line of defence involves activation of the white blood cells.

4. Briefly describe the second line of defence.

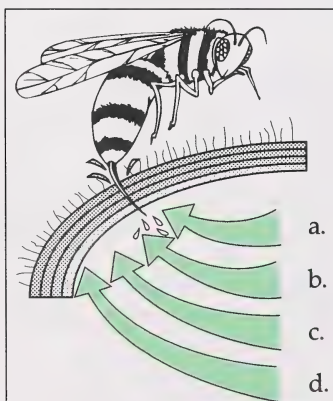
The third line of defence involves antibodies. Antigen-antibody reactions occur when proteins in your blood (antibodies) attack foreign invaders (antigens). Read Antigen-Antibody Reactions on pages 282 and 283 of your text and answer the following questions.

5. Describe the specific nature of antibody-antigen reactions.



To help you understand the interaction between macrophages, helper T cells, and B cells, study Figure 11.15 on page 284.

6. Describe the four lines of defence in order of response in the following graphic:





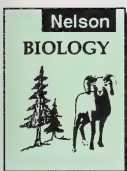
If you have access to the video *The Immune System: Your Magic Doctor*, watch the video as an excellent review of the immune system.

Vaccinations

Some diseases are so serious that the immune system has no time to respond. The victim dies first. In some cases, vaccination can provide protection from these diseases by stimulating the immune system before infection occurs.



The term *vaccination* was first used in the late 1700s by Edward Jenner, an English doctor. It is from the Latin word *vacca*, meaning cow. Discover why a cow was so important to the western discovery of vaccinations by reading pages 287 to 288 in your text.



Science Skills

- ☐ A. Initiating
- ☐ B. Collecting
- ☐ C. Organizing
- ☒ D. Analysing
- ☐ E. Synthesizing
- ☐ F. Evaluating

7. Edward Jenner used the scientific method in his discovery of a smallpox vaccine. Briefly outline what he did in the following steps.

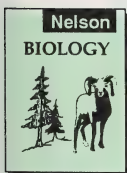
- | | |
|----------------|---------------|
| a. Observation | c. Test |
| b. Hypothesis | d. Conclusion |

Thanks to Edward Jenner's development of the smallpox vaccine and to the efforts of the World Health Organization (WHO), the smallpox virus has been successfully eliminated from Earth.

8. What two other vaccines are described in your text and have since saved thousands of lives?

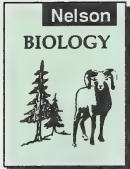
Science and technology continue the fight against disease. Read about some great discoveries on pages 289 to 291 in your text and answer the next questions.

9. Why would the new technology of making monoclonal antibodies ("magic bullets") be more effective than general chemotherapy in treating cancer?
10. Why is HIV (Human Immunodeficiency Virus) such a difficult virus for your immune system to fight?
11. Why do you rarely contract some diseases such as chickenpox more than once?



12. What lifestyle habits should be practised to help you build a strong immune system?

Check your answers by turning to the Appendix, Section 2: Activity 2.



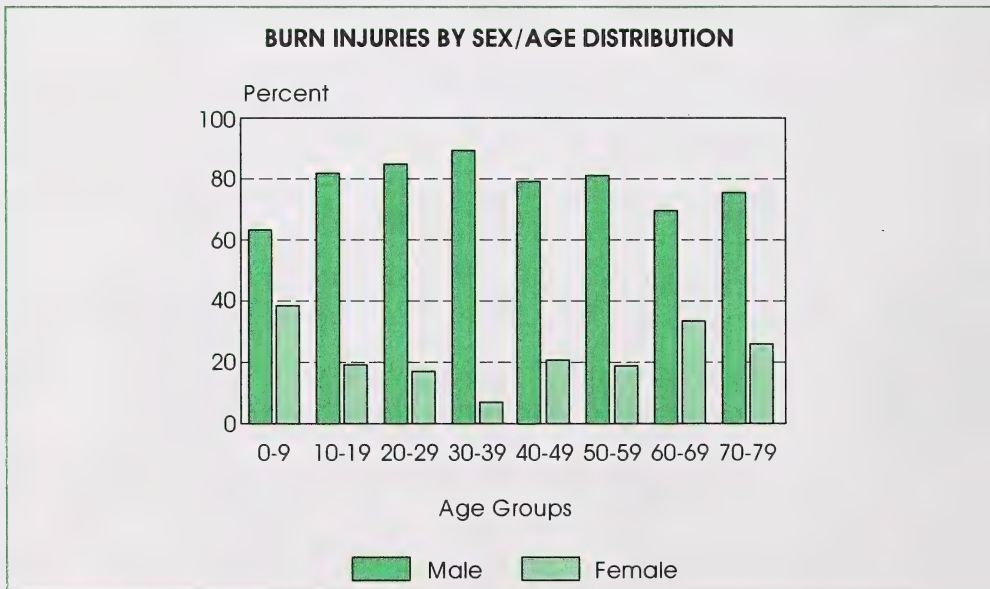
As you can see, your immune system is your friend; it's constantly guarding you from invaders. If its normal function is impaired, you would be forced to live in an artificial germ-free environment as did little David, the boy in the bubble pictured on page 270 of your textbook.

ACTIVITY

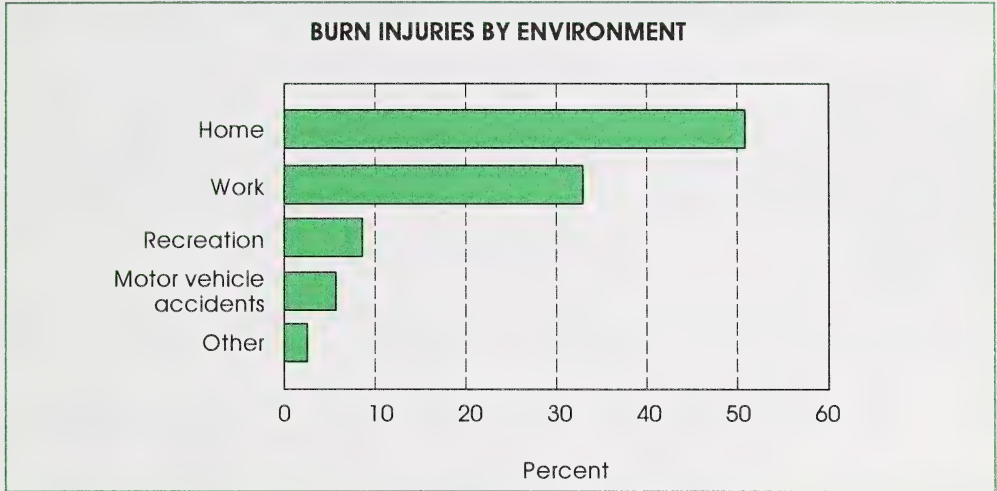
3

Severe Burns – A Case Study

Carefully examine the following graphs based on information provided by the Burn Treatment Unit at the University of Alberta Hospital. Check your age group and note the percentages of burn injuries by sex. Why do you think males are so much more at risk than females?



¹ Source is University of Alberta Hospitals, Firefighters Burn Treatment Unit, Northern Alberta Statistics, 1990.



1

Notice in the second graph the overwhelming percent of burns that occur in the home. What precautions could you take around the home to prevent a serious burn injury?

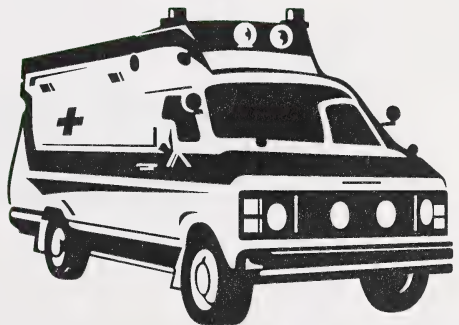
Consider the following scenario and answer the questions as you read along.

It's Friday night . . . Seventeen-year-old Susan was helping her Mother make doughnuts, a process which involved a deep fryer. Unfortunately, the electrically operated deep fryer was too close to the counter edge and as she turned to speak to her Mom, the fryer fell off the counter . . .

Boiling fat at 190°C spilled over her arms and abdomen . . .

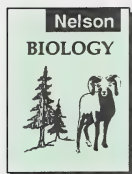
Although panic-stricken, her mother grabbed a nearby pot and repeatedly poured cold water over her. This served to decrease the temperature of the grease on Susan's skin to prevent deeper burning.

She then began removing Susan's clothing, shoes, and jewellery but didn't disturb any pieces of material that were sticking to her skin. Susan's mother then covered her with a bed sheet and tried to calm her while she phoned for the ambulance.



¹ Source is University of Alberta Hospitals, Firefighters Burn Treatment Unit, Northern Alberta Statistics, 1990.

1. Why wouldn't you continually splash the burn victim with ice cold water?
2. Why should you leave materials that are sticking to a burn victim's skin in place?

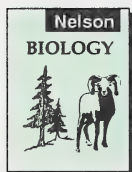


To understand why shoes and jewellery, such as rings and bracelets, need to be removed and to follow the hospital treatment that will be administered to Susan, you need to understand the concept of Capillary Fluid Exchange found on pages 264 to 265 of your textbook.

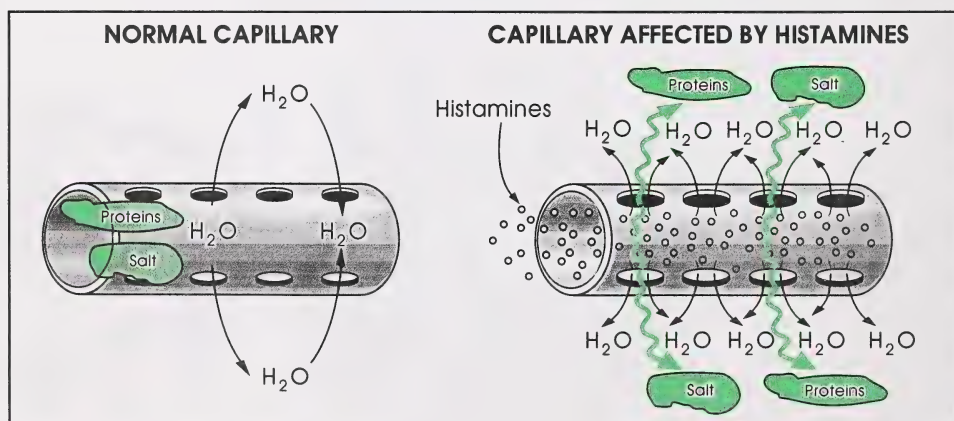
Read these pages and answer the following question.

3. a. What is the name of the lymph-like fluid that surrounds the capillaries and body cells?
b. Describe the two forces which act between the capillary and the extracellular fluid (ECF) to maintain blood homeostasis. Include the information from Figure 10.24 on page 265 in your discussion.

The balance of fluid between the capillaries and the body cells is dependent on an intact capillary membrane. Unfortunately in a severe burn such as that suffered by Susan, the initial immune response releases a chemical group called histamines which causes the capillary walls to become leaky. Salt and plasma proteins that normally are contained in the capillaries move out to the surrounding ECF.



4. Read the information on pages 264 to 265 of your textbook. Use that information and the following diagram to explain the changes in blood fluid volume and in the surrounding tissues that would result from such a change in capillary permeability.



edema – movement of water out of capillaries and into body tissues. This causes swelling and fluid loss.

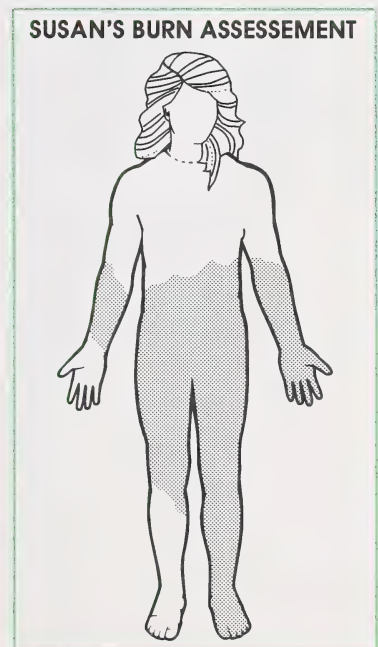
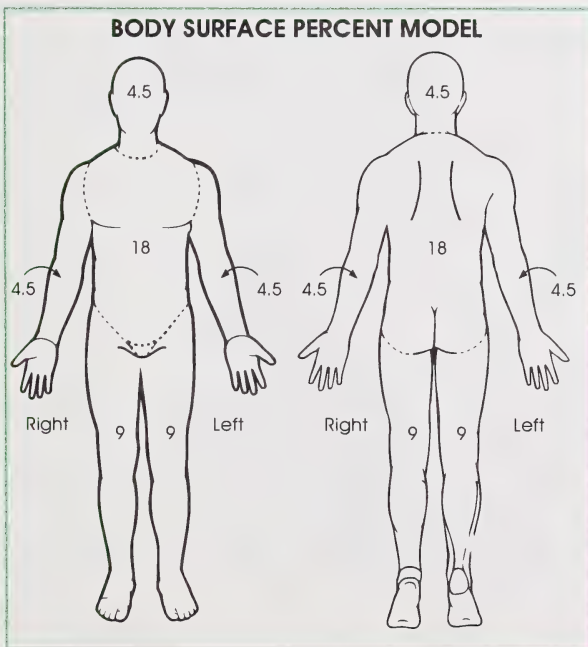
As massive **edema** results from a serious burn, can you see why it was quick thinking on the part of Susan's mother to remove Susan's rings and shoes immediately after the burn?

The ambulance arrived and the attendants immediately assessed the percent of Susan's body that had been burned. This is critical in calculating the amount of fluid she must receive by intravenous (I.V.). She could require as much as 5 L of fluid (a person's entire average blood volume) within the next sixteen hours.



5. Calculate the amount of I.V. fluid the attendants should administer to Susan.

- a. Use the following diagrams to determine Susan's burn area as a percentage of her entire body. Add up the numbers for her arms and abdomen. What is the percent burn of her total body surface area?



¹ Courtesy of University of Alberta Hospitals; Treatment Sheet and Nursing Care Plan, Burn Unit; May 1992.

- b. Susan weighs 60 kg. Use the following formula to determine how much I.V. fluid she requires.

$$4 \text{ cc/kg} \times \% \text{ burn area} \times \text{weight (kg)} =$$

6. Relate the loss of blood fluid volume to blood pressure and describe the problems which could result.

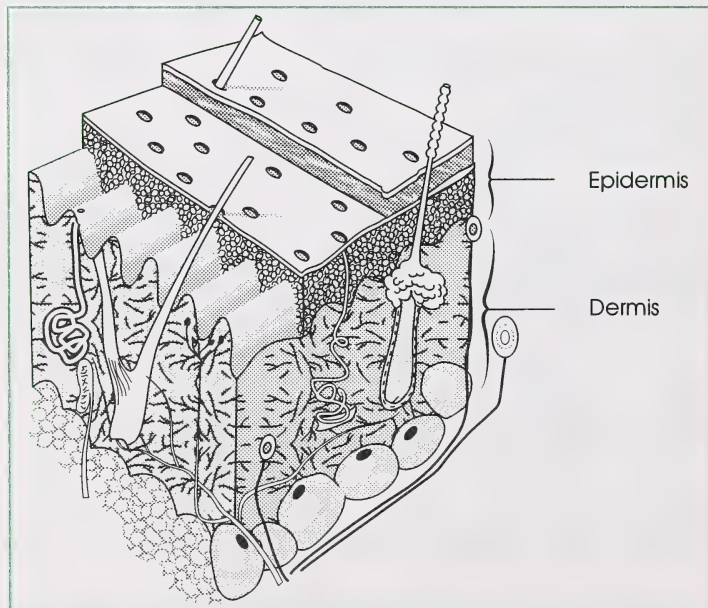
Susan arrived at the hospital. The medical staff examined her burn sites to determine the depth of burn to her skin.



epidermis –
outer layer of
skin

dermis – inner
layer of skin

Examine the following diagram showing the structure of the skin. Take special note of the **epidermis** and **dermis** layers. The dermis layer contains the capillaries. If the burn is severe and the dermis layer of the skin is destroyed, no regeneration of skin will occur. In these cases, grafting of skin from other areas of the body must be done.



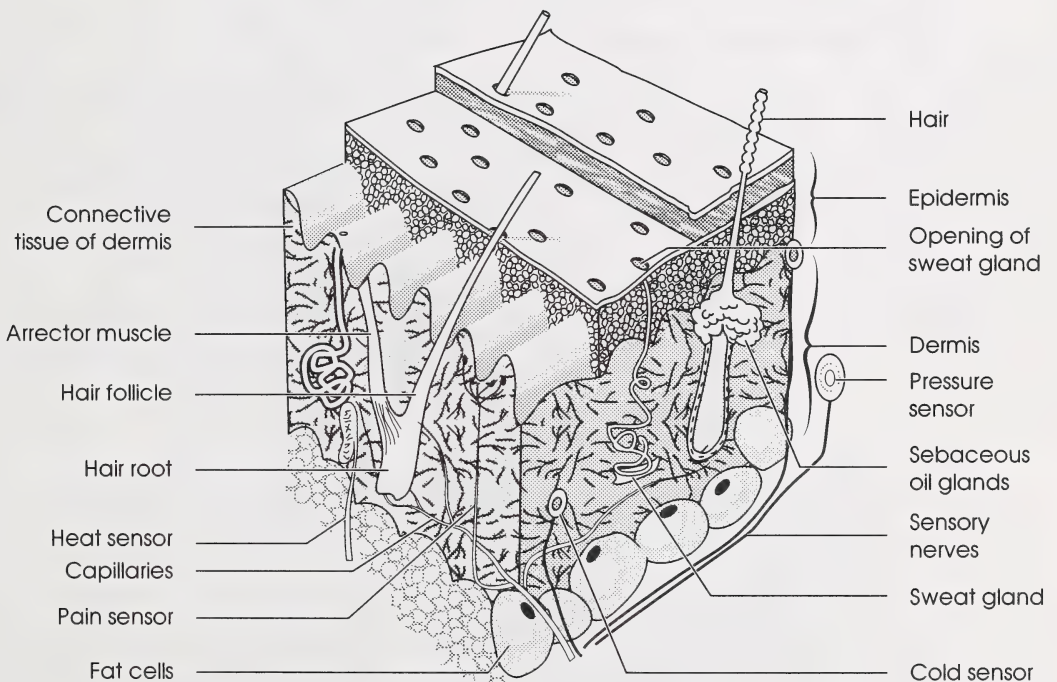
The following guide of damaged tissue layers determines the degree of burn.

First degree: epidermis and some dermis, red, blistered (e.g., sunburn); heals in five to ten days with minimal scarring

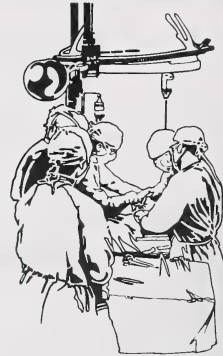
Second degree: epidermis to varying degrees of dermis, waxy pink, painful to pressure, 14-21 days or longer to heal depending on depth
Major scarring may occur if the dermis is badly damaged. Skin grafting may be necessary.

Third degree: epidermis and dermis are destroyed; muscle, fat, and bone may be involved; appearance of burn – dry, black to brown, large amount of edema, little pain
Skin grafting must occur.

7. Use the following diagram of the skin to name the structures that are located in the dermis layer.



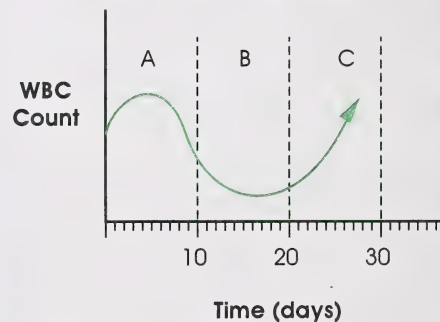
Susan was diagnosed as having moderate to severe second degree burns. A graft was necessary on an area of her right arm. The graft was taken from her thigh and healed in about ten days with considerable care.



A graft involves removing a section of skin from another part of the person's body – usually the thigh. The entire epidermis and part of the dermis are removed, the burn site is prepared, and the graft is stitched or stapled into place.

The major concern at this point is to prevent infection.

8. Use the information on degree of burns to diagnose the tissue damage that Susan had sustained as well as expectations for healing.
9. This graph indicates the change in white blood cell count after a severe burn and after treatment. Explain what accounts for the change in the curve at sections A, B, and C.



Susan's graft took well. She maintained a diet high in protein and carbohydrates which improves rate of healing. Her own capillaries underlying the graft were supplying blood flow to the graft by the fourth day and the grafted skin had a healthy pink appearance. After ten days it had healed. To care for the area throughout her life Susan must lubricate it with hand cream as oil gland secretion has been lost. Protection from the sun to avoid sunburn to the grafted area is essential. The remaining burned areas healed with minimal scarring.

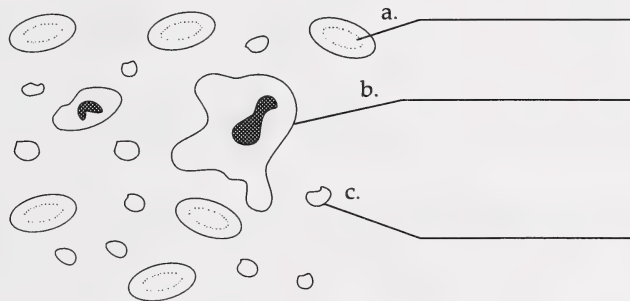
Check your answers by turning to the Appendix, Section 2: Activity 3.

Follow-up Activities

If you had difficulty understanding the concepts in the activities, it is recommended that you do the Extra Help. If you have a clear understanding of the concepts, it is recommended that you do the Enrichment.

Extra Help

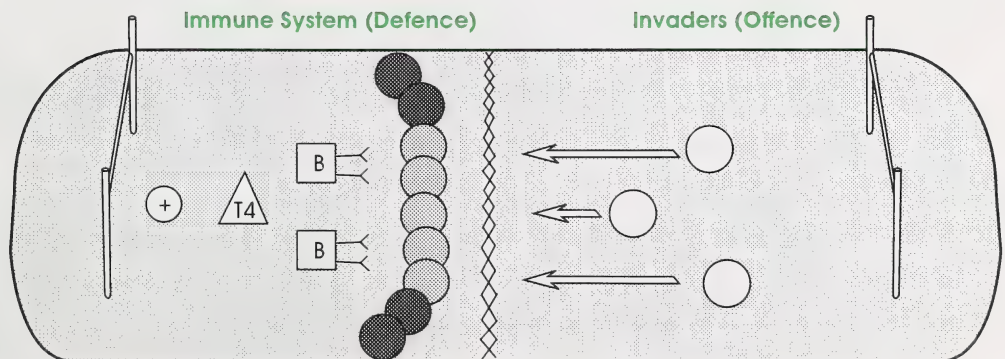
1. Identify the blood cells in the following diagram and give their main function. Refer to page 274 in your text if necessary.



The following analogy should help you understand the interaction of cells involved in the immune response.

Analogy

Imagine your body's immune system as the defensive line in a football game. This defensive line is shown on the left side of the field. The offensive line represents invading organisms – shown on the right side of the field.



The centre line represents the first line of defence.

2. What acts as the first line of defence in your body?

The second line of defence is called into play . . .

The five defensive linesmen behind the line of defence are the macrophages. The macrophages engulf and eat the invaders by carrying out phagocytosis.

The T4 helper cell (triangle) is the captain and instructs the defensive line to attack.

The four shaded defensive backs represent the killer T cells. Their job is to tackle and bring down the opponents.

The square cells (safetys) then begin releasing their antibodies which bind to the membranes of the intruders making them more easily eaten by the linebackers (macrophages).

Once the battle is won, the referee (white with cross) who represents the suppressor T cells calls off the play.

3. Based on the preceding analogy, match each of the following lymphocytes with their role in the immune response.

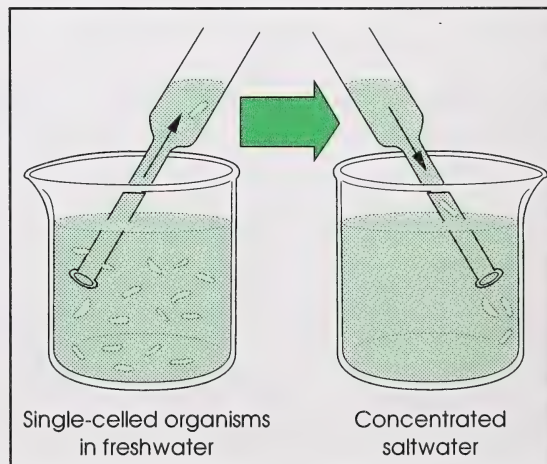
Lymphocytes

Role

- | | |
|------------------------|---|
| a. T4 helper cell | i. produces antibodies |
| b. B cell phagocytosis | ii. engulfs pathogens by phagocytosis |
| c. macrophage | iii. mobilizes the lymphocytes into action |
| d. killer T cell | iv. destroys the invader with toxic chemicals |

A severe burn disrupts the homeostatic mechanism that maintains blood fluid volume. This occurs because damaged cells produce a chemical which increases the permeability of the capillary wall. The plasma proteins and ions can now leak out into the extra-cellular fluid (ECF). This destroys the osmotic pressure within the capillary which normally causes water to move back into the blood from the tissue. So water moves out of the capillaries and into the tissues.

4. Examine this diagram and answer the question.

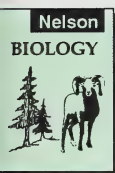


Explain how and why the volume of single-celled organisms would change if moved from a freshwater habitat into water with a high salt concentration.

Check your answers by turning to the Appendix, Section 2: Extra Help.

Enrichment

Do one or more of the following:



1. Read about the Rhesus (Rh) factor on page 279 in your text. Visit a clinic and ask if you can find out your blood type.
2. Hemophilia is an inherited disease in which the blood clotting process is disrupted. People with hemophilia are in danger of bleeding to death even if only slightly injured. Research the treatment that is available to hemophiliacs.



3. If you have access to a laser videodisc player and the laser videodisc entitled *The Living Textbook: Life Science* (Side 2), view the following film clips as a review of blood components. (All clips are from Chapter 13.)

14805 Living blood cells

19769 Antibodies, lysis, agglutination, and phagocytosis

16313 Platelets and clotting

4. Read the section entitled Blood Groups on page 277 of your text and explain why a person with blood type A can only donate blood to a person with blood type A and AB.

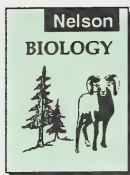


5. Use your microslide viewer and Set 95 of microslides entitled Human Blood to do the following investigation:

- View Slide 5 – Wet Mount Slide. Draw the appearance of blood type B in type B plasma (Bp) and as it appears agglutinated in type B plasma. Record the magnification.
- View Slide 6 – Fibrin. Draw the appearance of fibrin threads which form the blood clot. Record the magnification.

- a. Explain why the results in Slide 5 indicate the blood tested is blood type B.
- b. Describe the sequence of events in blood clotting which causes fibrin formation as shown in Slide 6?

6. When donating blood, your blood flows from a tube into a plastic bag. The blood donor clinic places a chemical in the bag which precipitates out blood calcium. Why is this procedure necessary?



You may want to visit a Red Cross Blood Donor Clinic and donate blood if you are over seventeen years of age. Natural human blood and blood products are always needed for transfusion. Artificial blood is still very new. Read about artificial blood on page 280 in your text.

Check your answers by turning to the Appendix, Section 2: Enrichment.

Conclusion

Throughout this section you have seen the role of individual blood components in providing nutrients and oxygen to cells and in protecting them from invading pathogens. However, body cells must be protected further from the chemical wastes that they produce. This type of protection requires the body to devise a mechanism to get rid of these wastes rather than having them continually build up within a closed circulatory system. This critical role of eliminating wastes is the role of the kidneys. How these two organs are able to perform this function in addition to monitoring blood water and ion levels will be investigated in the next section.

30

Section 2 Assignment: Your Lifestream

Review the Evaluation information found in the introductory pages of this module.

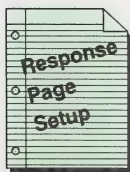
It is important to number and clearly identify each page with the following information at the top:

Biology 20 – Module 7

Section 2 Assignment

Page #

Name and ID#



Be sure to write legibly. Leave a wide left margin and number all of your pages.

1. Outline the main functions of the following blood components. (3 marks)
 - a. red blood cells (erythrocytes)
 - b. white blood cells (leukocytes)
 - c. platelets
2. a. What are the two main structural differences between white blood cells and red blood cells? (2 marks)

- b. Which blood cell is able to reproduce inside the circulatory system and why? (2 marks)

3. Use the information in the following chart to answer questions a. and b.

INDIVIDUAL	WBC COUNT/mm ³	HEMOGLOBIN CONTENT OF BLOOD (g/100 mL)
A (normal)	8 000	15
B	12 000	12
C	8 100	20
D	8 500	15

- a. Which individual most likely lives at a high altitude? Explain. (2 marks)
- b. Which individual is fighting a serious infection? Explain. (2 marks)

Reproduce the science skills assessment box after your response to this question. Remember to indicate your evaluation of your skill level for each identified science skill. Be sure to include the spaces for teacher assessment.

Self: A.	☐	B.	☐	C.	☐	D.	☐	E.	☐	F.	☐
Teacher: A.	☐	B.	☐	C.	☐	D.	☐	E.	☐	F.	☐

4. What is lymph and how is it related to the immune system? (2 marks)
5. Explain how vaccines help in combating diseases. (3 marks)
6. The HIV that causes AIDS severely impairs the body's immune system. What action does this virus take that is so harmful to the immune system? (2 marks)
7. Use your knowledge of capillary structure and function to explain how edema (tissue swelling) occurs with severe burns. (4 marks)
8. Why is the risk of infection so great following a severe burn? (2 marks)
9. Macrophages are specialized white blood cells that carry out phagocytosis. Explain this process and its role in the immune response. (2 marks)
10. What are antibodies and which blood cell in the immune system releases them as part of the immune response? (2 marks)
11. Describe the symptoms which would be associated with a person suffering from anemia. Relate your answer to a blood component. (2 marks)

Science Skills

☐ A. Initiating

☐ B. Collecting

☐ C. Organizing

☒ D. Analysing

☐ E. Synthesizing

☐ F. Evaluating

SECTION

3

Excretion

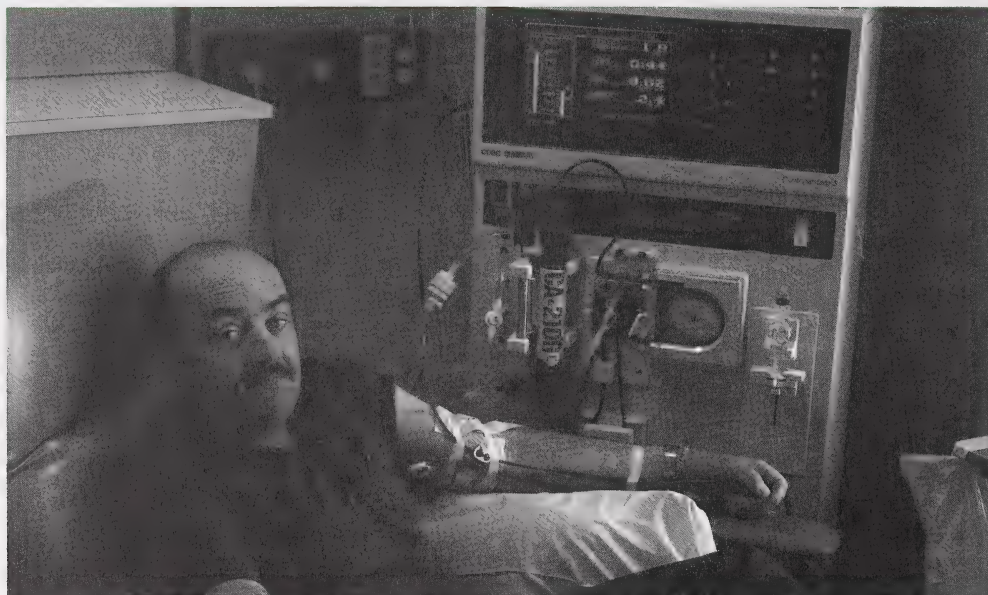


PHOTO SEARCH LTD.

Three times a week, three to four hours a day, approximately five thousand Canadians must connect themselves to a hospital machine.

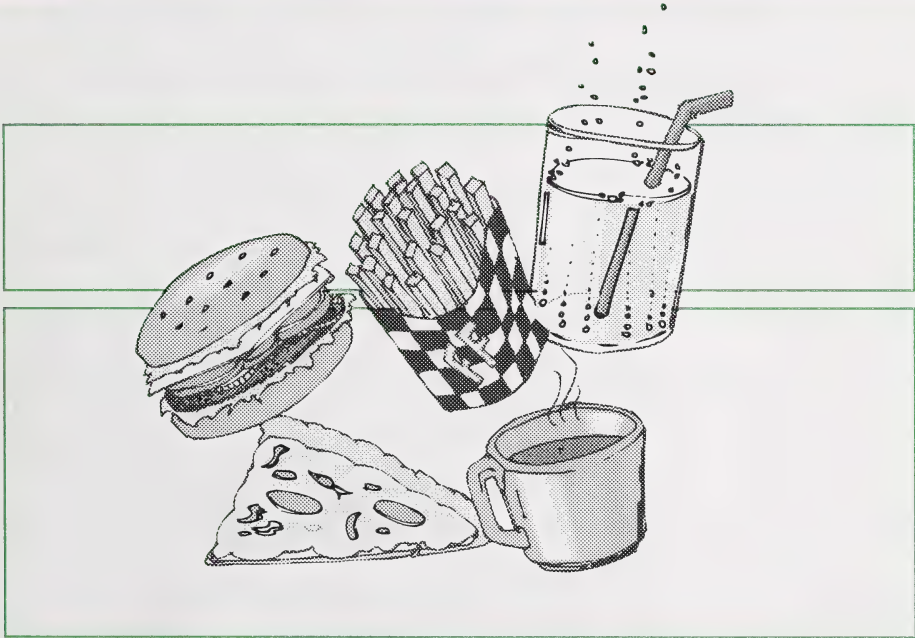
If they miss this twelve-hour appointment, they could die within a week. This is the power of your kidneys.

Why are these two small fist-sized organs so critical to survival? What is their contribution to internal homeostasis?

Throughout this section you will participate in three activities which will lead you to an appreciation of your kidneys. In the first activity the close association between the circulatory system and kidney function at the microscopic level will be investigated. The second activity helps you understand about the formation of urine and about osmoregulation. The third activity takes you into the technology of the kidney (dialysis) machine and kidney transplants.

ACTIVITY

1 The Kidneys – A Balancing Act



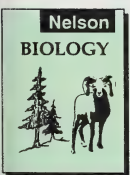
Think of the variety of food you eat in a day, the amount of liquid you drink, and all the activities in which you participate. Everything you eat, drink, and do affects your blood chemistry. Just as your heart had to increase its pace as you became more active, so must your kidneys adjust to different conditions. As blood chemistry changes, the kidneys react by excreting more or less chemicals in the urine to maintain a desired blood chemical level.

Read pages 314 to 315 in your text as an introduction to excretion and then answer the next questions.

1. Describe the three main roles of the kidneys in maintaining a balanced blood chemistry.

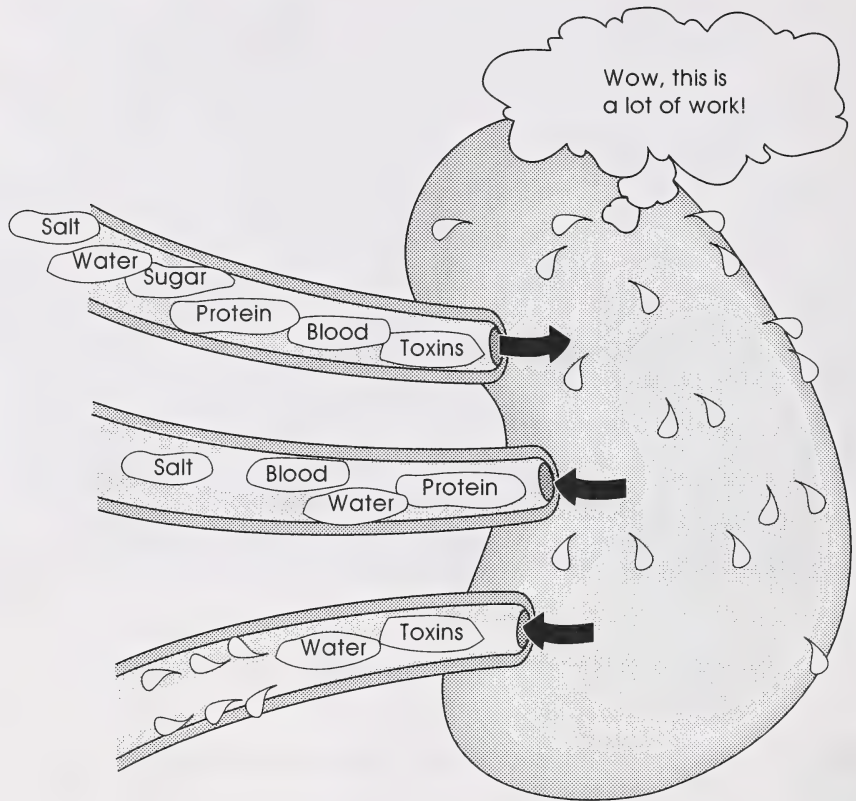
Although the kidneys are the chief chemical adjusters in maintaining blood homeostasis, other organs also assist in the role.

2. What are the excretory functions of the following organs?
 - a. lungs
 - b. large intestine
 - c. liver

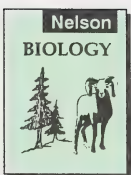


Dietary protein is essential to life and yet, ironically, some of the by-products of protein digestion are very toxic. You will recall from studying digestion that proteins are broken down by digestive enzymes into amino acids. Once these amino acids are absorbed by the villi of the small intestine into the bloodstream, they are used to construct new cell proteins. Unfortunately, during digestion some molecules of nitrogen and hydrogen are released. These could form ammonia, which is very toxic.

3. Describe the role of the liver in the metabolic breakdown of an amino acid and the formation of urea.



If your kidneys don't work, the consequences become serious very quickly. So how do they do it?



The Big Picture

Prior to examining the microscopic level at which the kidneys function, it is important to understand the anatomy of the excretory system.

Read pages 315 to 316 in your text and answer the following questions.

Blood travels to the kidneys, urea is removed, and the blood returns to the body. The urea is excreted in urine.

4. Examine Figure 13.3 on page 316 in your text and answer the following questions.

- a. What structure carries blood from the heart to the kidneys?
- b. What structure carries blood from the aorta into each kidney?
- c. What structure carries blood out of each kidney?
- d. What structure carries blood back to the heart?
- e. What structure carries urine from the kidneys to the bladder?
- f. What structure carries urine out of the body?
- g. Does Figure 13.3 depict a male or female urinary system? Why?

Examine the cross-section of the kidney in Figure 13.3 on page 316. Note: The term *renal* is Latin for *kidney*.

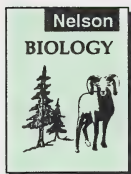
5. Find the renal cortex and the medulla. Describe their specific location in the kidney.
6. The renal artery directs blood _____ each kidney and the renal vein directs blood _____ each kidney. The vessel carrying blood that has been purified by the kidney is the _____.

Check your answers by turning to the Appendix, Section 3: Activity 1.

By now you're probably getting the idea that the kidney is a kind of filter. This is a correct impression. Filtration occurs in microscopic structures lying partly in the cortex and partly in the medulla. The structures are called nephrons.

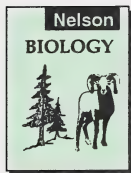
Each kidney is made up of approximately one million nephrons.

Examine Figure 13.4 on page 317. Note that each nephron tubule is in close contact with blood capillaries. This association is critical. It's the mutual swapping of chemicals between the blood and the tubular fluid that enables the kidney to maintain blood homeostasis. The fluid that moves out of the nephron at the end of all the changes is urine. Blood returns to the heart.



Briefly examine Figure 13.6 on page 319. This is a simplified diagram but it illustrates the essential functions of a nephron.

7. a. Name the three necessary functions of a nephron.
- b. Which process likely depends on blood pressure?
- c. Which two processes likely use active transport?



Now go back to Figure 13.4 on page 317.

8. Read through the section entitled Formation of Urine from page 317 to 319; explore the details of these three processes in the following questions.
 - a. Initial filtration occurs when blood pressure forces fluid out of the _____ and into _____.
 - b. Blood enters the glomerulus through the _____ and leaves through the _____.
 - c. Describe what normally passes into Bowman's capsule.
 - d. What blood components should not pass into Bowman's capsule?
9. a. What two processes occur in reabsorption?
- b. What substances are moved back into the blood to create a concentration gradient?
10. After water had been reabsorbed into the blood, what remains in the tubule?
11. Where does tubular secretion occur and what substances are secreted?

Check your answers by turning to the Appendix, Section 3: Activity 1.

PATHWAYS

If you have access to the laser videodisc *Life Science – Principles of Biology* (side 2), do Part A.
If you do not have access to this laser videodisc, do Part B.

Part A

Investigation: The Kidney Nephron in Action

Objective

Observe the movement of dye in a living nephron.

Background Information

A micropipette is a very thin glass tube that can be used to add or remove liquids from small spaces.

Procedure

Load the laser videodisc *Life Science* (Side 2) into the laserdisc player and search for chapter 16, Kidney: Structure and Function (Frame 30353).

View the videoclip entirely without answering any questions. Try to follow what is being demonstrated by the two dyes.

Note: The clip is approximately only two minutes in length, so you may want to view it a few times until you understand what is being demonstrated. Sound is delayed – wait for it.

Observation

12. a. What happened to the dye with large molecules?
b. What happened to the dye with small molecules?
13. Looking at the surface of the kidney nephrons, what happened as the dye moved through the nephron?

Analysis and Interpretation

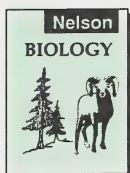
14. Explain the results with the injected dye made of large molecules.
15. Why did the dye disappear from the surface of the kidney (cortex) and then reappear after a few seconds?

Application

16. Explain why the presence of blood in urine is possibly an indication of kidney disease?

Check your answers by turning to the Appendix, Section 3: Activity 1.

Part B



Follow the Case Study: Comparing Solutes in the Plasma, Nephron, and Urine on page 320 of your text.

Note: Rewrite the top of the chart from your text to read in this order: Solute, Glomerulus, Bowman's Capsule, Loop of Henle, Collecting Duct (i.e., switch the placement of "Bowman's Capsule" with the "Glomerulus"). Answer the following questions.

17. Do textbook question 1 from the Case-Study Application Questions on page 320.
18. Unfortunately no data was available for glucose. Based on your background reading, would you expect to find glucose in Bowman's capsule if the investigation was repeated? Explain your answer.
19. Do textbook question 3 on page 320.
20. If the solvent water was added to the chart, would the amount of water decrease or increase by the time it reached the collecting duct. Explain.
21. What normal blood constituents could substance X represent?

Check your answers by turning to the Appendix, Section 3: Activity 1.

ACTIVITY

2

Osmoregulation and Urine Formation

Your body contains about 5 L to 6 L of blood. In a normal twenty-four-hour day, your blood passes through your kidneys over thirty times. Quick math will tell you that on the average about 200 L of filtrate flow through the kidney tubules each day. Actually 99% of the filtrate is returned to the blood leaving you to excrete approximately 1 L to 2 L of urine per day.

osmoregulation
– maintaining a
water balance in
the body

Control of blood-water balance by the kidneys is a critical function. It is called **osmoregulation**. Think back to your studies of respiration, digestion, and circulation; what is the role of water in your body? You might recall some of the following points – water acts as a solvent for dissolving food particles in digestion, it's a transport medium for all blood components, it controls body temperature by evaporation from the body surface (sweating), and most chemical reactions in the body occur between chemicals dissolved in water. These points, plus the fact that you are 70% water, should definitely convince you of the importance of water!

Maintaining an adequate internal water supply when 200 L of filtrate are flowing through the nephrons per day is an incredible challenge to the kidneys.

PATHWAYS

If you have access to the video, *Homeostasis: Osmoregulation*, do Part A.
If you do not have access to this video, do Part B.

Part A

Watch the video *Homeostasis: Osmoregulation*; then answer the following questions.

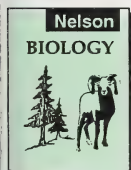
Note: This video restricts its segment to osmoregulation (control of water movement) only. The critical role of the kidney in eliminating wastes such as urea and balancing blood pH are not mentioned here. Keep in mind that urea is secreted throughout the nephron as are hydrogen ions in most cases.

Part B

Read pages 320 to 322 in your text to gain an understanding of how the kidneys regulate water balance in your blood.

1. What percentage of water has returned to the blood by the time the filtrate has left the proximal tubule?
2. What is the advantage of having a high sodium ion concentration in the kidney medulla?
3. The hormone **ADH** is secreted by the pituitary gland as a response to high osmotic pressure. ADH affects the kidney nephrons and prevents too much water from escaping in the urine.
 - a. What sorts of events increase the osmotic pressure in the blood stream and how does this increase affect the release of ADH?
 - b. What effect does ADH have on the nephron?
 - c. Explain why caffeine and alcohol increase urine output. The video restricts its explanation to one reason; you may have other answers. Check the Biology Clip on page 322 of your text.

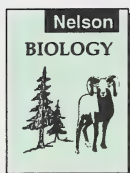
Check your answers by turning to the Appendix, Section 3: Activity 2.



ADH –
antidiuretic
hormone

Investigation: Diagnosis of Kidney Disorders

In this investigation you will be analysing simulated urine samples. Urine analysis is routinely carried out in medical clinics as a detection of kidney disease.

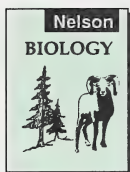


This investigation is similar to the laboratory on page 326 in your text; however, you will follow a slightly different procedure and will perform one additional test.

Objective

Note the objective in your text.

Background Information



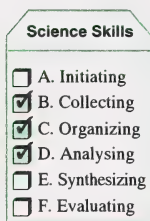
Read the section entitled Kidney Disease on pages 323 to 324 in your textbook.

4. Summarize the changes in urine composition which are associated with the following diseases: diabetes mellitus, diabetes insipidus, and Bright's disease. Include an explanation in your summary.

Materials

- colour chart
- distilled water
- four small test tubes
- masking or label tape*
- small glass or beaker to hold test tubes*
- four urine samples (simulated) W, X, Y, and Z
- four Multistix (reagent strips for urinalysis)
- 10 mL graduated cylinder

*supplied by student



Procedure

- Using a graduated cylinder, measure 7 mL of urine sample W and place it in a test tube. Label the test tube W. Rinse the graduated cylinder with distilled water and repeat the procedure for samples X, Y, and Z.
- Label each Multistix W, X, Y, or Z with a pencil.
- Dip a Multistix in each of the test tubes, remove from the test tubes, and leave for one minute. Lay the Multistix out so that you don't mix them up.
- Compare the colour bars for glucose, specific gravity (S.G.), ketones, and protein with the chart provided.

Observations

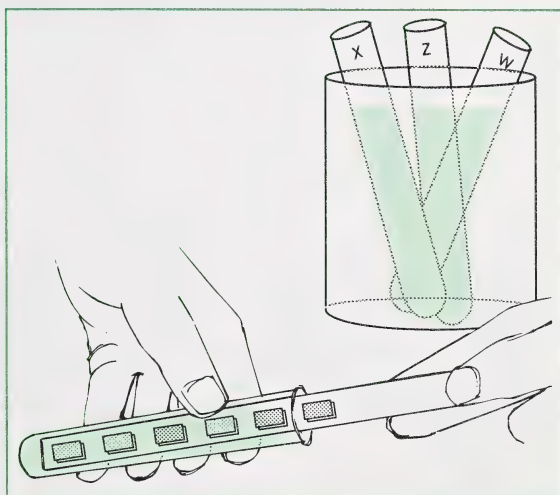
- Record the values for each of the samples in a table similar to the following one.

SAMPLE	GLUCOSE	S.G.	KETONES	PROTEIN
W				
X				
Y				
Z				

Analysis and Interpretation

- Which sample(s) may indicate diabetes mellitus? Explain your answer.
- Which sample(s) may indicate diabetes insipidus? Explain why.
- Which sample(s) may indicate Bright's disease? Explain why.
- Which sample is most normal?

Notice the other possible tests on the Multistix. These are used in medical clinics.



Wash out your test tubes and discard the Multistix.

Check your answers by turning to the Appendix, Section 3: Activity 2.

The yellow colour of urine is definitely observed but seldom discussed. For interest, its pale to deep yellow colour is due to the presence of a pigment called bilirubin which results from the liver's destruction of aging red blood cells. It's actually the hemoglobin that colours the urine. At times you might observe brilliant yellow or shocking pink – it's nothing to panic about. It all depends on what you've eaten – vitamin C and beets, respectively, may cause such technicolour changes.

ACTIVITY

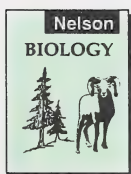
3 When Kidneys Fail

- As much as 80% of a remaining kidney has to be damaged before problems can be detected.
- Every day, two Canadians receive a kidney transplant!
- At the University of Alberta hospital alone, 40 to 60 kidney transplants are done per year, yet 200 to 300 transplants are needed!
- Only 24% of all licensed automobile drivers have signed their organ donor cards.

Read each of these statistics. Do you recall from the introduction the fact that a person with kidney failure must connect to a machine for three to four hours per day, three times per week? This artificial kidney that five thousand Canadians depend on for survival purifies the blood by a process called dialysis.

This activity explores three topics related to kidney failure: the effect on body functions, the remarkable technology of dialysis and transplants, and the possible lifestyle implications to keep your kidneys healthy.

Physiological Impact



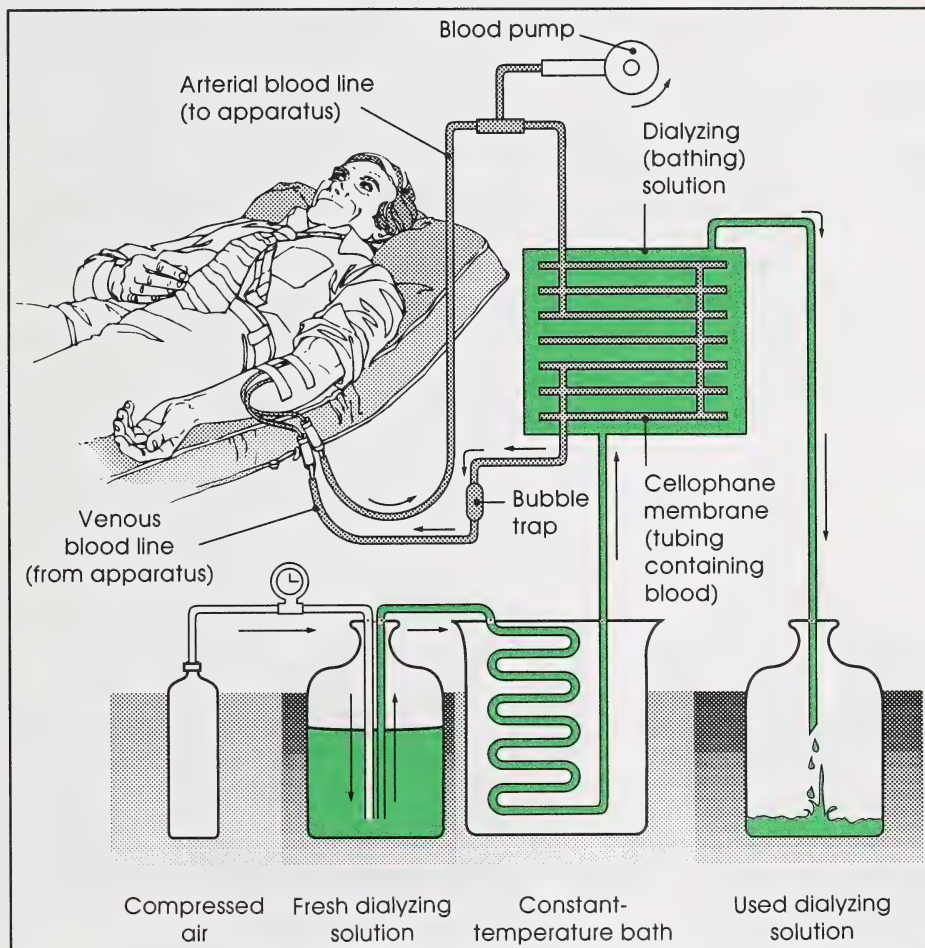
Review pages 314 to 326 in your textbook.

1. Based on your knowledge of kidney function, speculate as to the changes that will occur to the blood and tissues of the body if renal failure occurs and urine production stops.

Symptoms of a person suffering from total kidney failure (termed uremia) include fatigue, vomiting, diarrhea, laboured breathing, and heartbeat irregularities. The last two symptoms are due to water retention. Joint and muscle aches result from the buildup of urea and creatine (breakdown products of nucleic acids). The excess sodium and potassium interfere with the heart beat which when combined with the strain of pumping an excess volume of blood can result in a heart attack. Without dialysis, the person will go into a coma, suffer convulsions, and die.

Dialysis and Transplants

Dialysis involves the exchange of ions and wastes from a person's blood through a permeable membrane to a solution that is balanced with the ion concentration of purified blood which is called dialysate fluid.

**EXAMPLE OF DIALYSATE FLUID CONTENTS**

	mmol/L		mmol/L
potassium	0-3	glucose	11.1
sodium	137-160	chloride	106-109
calcium	1.55	acetic acid	3
magnesium	0.75	sodium bicarbonate	0.35

1

This is mixed with treated water in a proportion of 1:34.

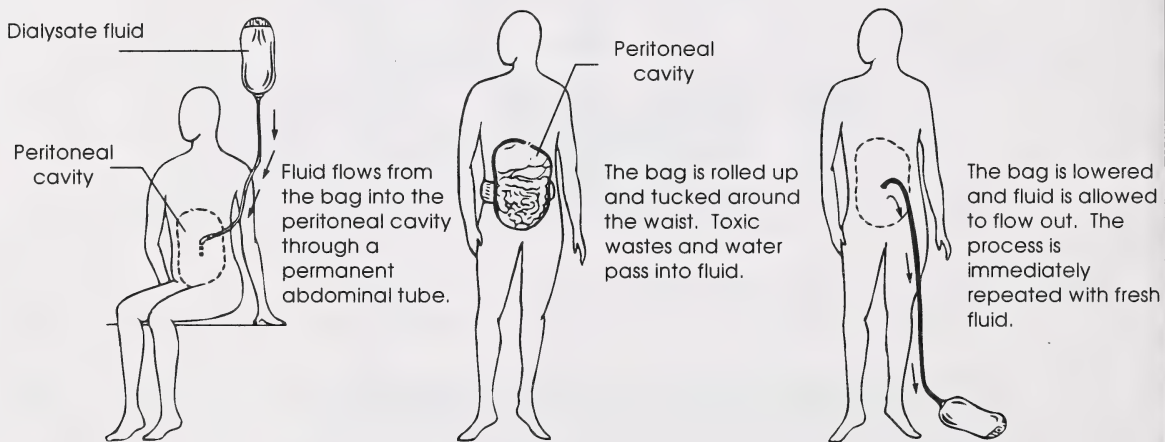
¹ Courtesy of University of Alberta – Dialysis Centre.

2. Assuming the person's blood contains higher levels of each of these components, what will occur as it passes by the membrane separating the blood from the dialysis fluid?

The two common dialysis are hemodialysis and peritoneal dialysis.

Hemodialysis is the scenario mentioned at the beginning of this section. A needle is inserted in a main vein of the patient's body with a tube connecting to a series of hollow straw-like membranes which are surrounded by the dialysate fluid. The blood flows through the middle of the membranes. The patient is connected to the machine for three to four hours, three times a week in order to keep blood in homeostasis.

Peritoneal dialysis can be done at home. In your studies of digestion you may have learned that a thin membrane surrounds the abdominal organs. This membrane, called the peritoneum, is full of capillaries and therefore can act as an effective barrier between the bloodstream and the dialysis fluid. A tube is implanted into the abdomen of the patient. Gravity is used to allow dialysate fluid to flow from a bag into the abdominal cavity. The bag is folded around the waist and the ion and waste exchange takes place. This exchange must take place four times a day.



Since its beginning in the 1950s, dialysis has been a successful form of treatment for many people; a few Albertans have been on dialysis for over twenty years.

As useful as dialysis is, the inconvenience of such a regimented program affects the lives of these patients dramatically. In addition, dialysis treatment costs the health care system from \$40 000 to \$50 000 per patient per year. Transplants, on the other hand, can save the health care system at least \$250 000 over the lifetime of that patient. (Kidney Foundation of Canada statistics, 1988)

Transplant Technology

As difficult as it is to find a donor match, transplants are often considered the treatment of choice. Kidney transplantation has a wonderful track record with over 80% success after the first year. Every day, two Canadians receive a kidney transplant. In Northern Alberta alone, there have been 724 kidney transplants performed as of September 1991. One person in the United States is still enjoying a good quality of life twenty-six years after receiving a kidney transplant.

The biggest problem related to transplantation besides concern with organ rejection is obtaining a suitable organ. At the University of Alberta approximately forty to sixty transplants take place per year. However 200 to 300 people are on the waiting list. If everyone signed the organ donor card on their driver's license, there would be more than enough organs to transplant everyone waiting.

Lifestyle Implications

Kidney disease is a general term for many different conditions. Textbooks of over 1000 pages have been written outlining kidney diseases. Most of the diseases are caused by bacterial infections and possibly chemical toxins. Lifestyle habits, such as diet and level of exercise, have not been shown to directly cause renal failure. However, your lifestyle can affect kidney function somewhat. High blood pressure (hypertension) can put a strain on your kidneys and this can be influenced by both diet and regular exercise.



3. Discuss the role of diet and regular aerobic exercise in lowering blood pressure.

Generally lifestyle becomes more significant once kidney disease has been diagnosed. For example, a diet restricting intake of sodium, potassium, and water is critical to assisting a damaged kidney. Normally, your kidneys can handle any junk food you take into your system.

WARNING

Warning signs of kidney disease include swelling of parts of the body, lower back pain, burning sensation when urinating, changes in frequency of urination, bloody or coffee-coloured urine, and/or high blood pressure. See your doctor if any of these symptoms have been noted.

Kidney disease will affect one out of every twenty persons in your community. Keep healthy and be in tune with your body to enable early detection of kidney disease.

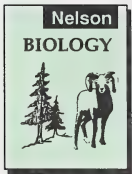
Check your answers by turning to the Appendix, Section 3: Activity 3.

Follow-up Activities

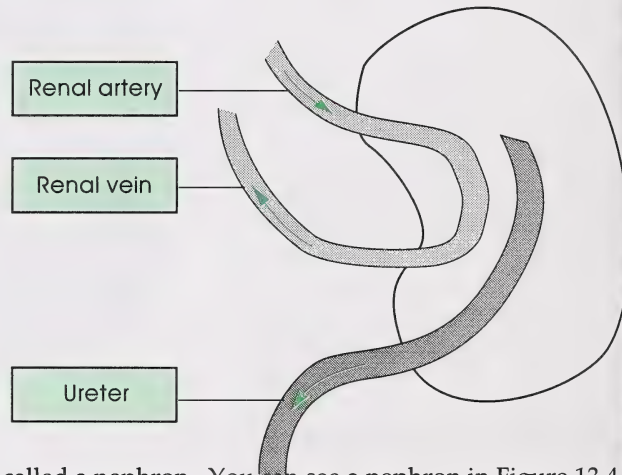
If you had difficulties understanding the concepts in the activities, it is recommended that you do the Extra Help. If you have a clear understanding of the concepts, it is recommended that you do the Enrichment.

Extra Help

Your kidneys act as filters, constantly removing wastes and adjusting chemicals in your blood to keep you healthy.



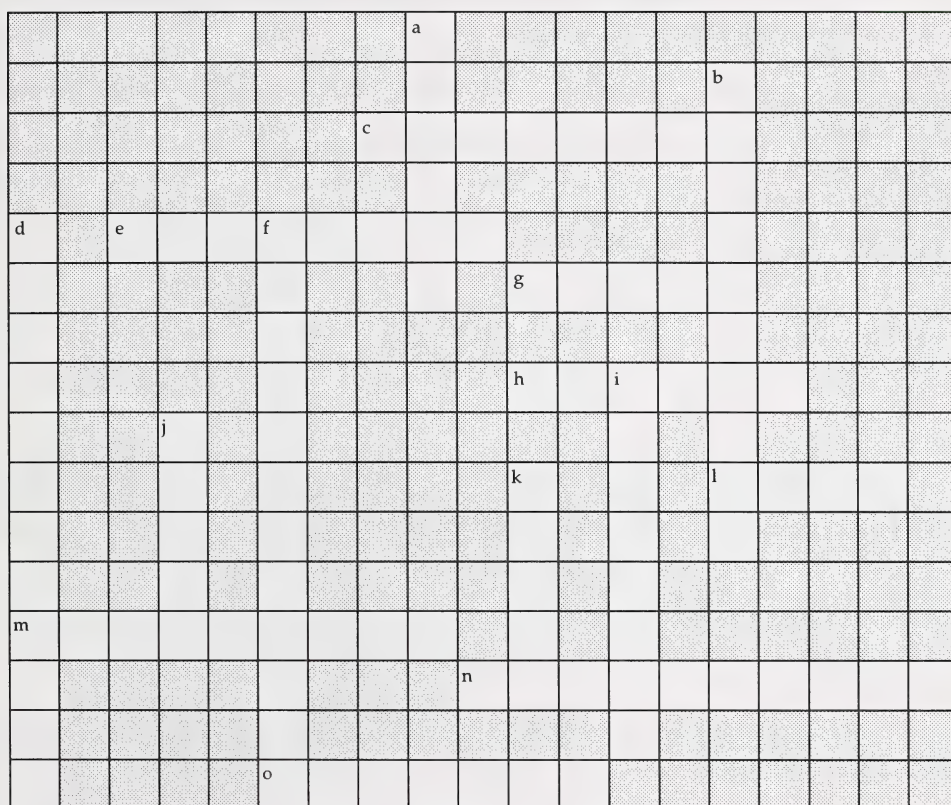
1. Use the information from pages 315 to 319 of your text to make lists of the components in these boxes.



The actual filter in the kidneys is called a nephron. You can see a nephron in Figure 13.4 on page 317 of your text.

2. a. What wastes are secreted by the cells of the nephron? Explain.
- b. What substance depends totally on the concentration of sodium to be reabsorbed?

3. Complete the following crossword puzzle.



Across

- c. first tubule section
- e. ion of acidity
- g. tubule looping in medulla
- h. ion which helps reabsorb water
- l. made in liver from amines
- m. waste movement from blood into nephron tubule
- n. membrane surrounding organs in abdomen
- o. microscopic kidney filter

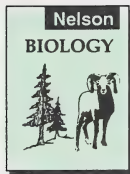
Down

- a. outer region of kidney
- b. capillary in Bowman's capsule
- d. high blood pressure
- f. material recovery
- i. artificial purification of blood
- j. converts nitrogen wastes to urea
- k. waste product of kidneys

Check your answers by turning to the Appendix, Section 3: Extra Help.

Enrichment

Do any or all of the following.



1. Answer question 1 in the Critical Thinking Questions on page 329 in your text.
2. Research how kidney dialysis machines function.
3. Contact the Kidney Foundation of Canada and ask for information on kidney disease and transplants.
4. Visit a health clinic and ask about urine analysis.
5. Read the Social Issue on page 329 in your text and seek out the opinion of your dentist on this issue.

Check your answers by turning to the Appendix, Section 3: Enrichment.

Conclusion

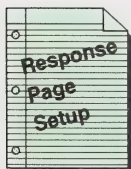
Modern medical technology has improved the lives of millions of people and in the case of dialysis it has saved many lives. Despite the ability of the dialysis machine to replace basic kidney function, kidney transplant is still the preferred treatment for renal failure. One small organ, the size of your fist, can maintain internal homeostasis as well as a machine that costs \$40 000 to \$50 000 per patient per year to run. Your kidneys secrete hormones, excrete metabolic wastes, and reabsorb essential nutrients and water – two small but critical organs upon whose health your health depends.

40

Section 3 Assignment: Excretion

Review the Evaluation information found in the introductory pages of this module.

It is important to number and clearly identify each page with the following information at the top:



Biology 20 – Module 7 Section 3 Assignment Page # Name and ID#

Be sure to write legibly. Leave a wide left margin and number all of your pages.

- The kidney can be considered an organ of retention rather than as an organ of excretion. Identify a substance retained by each of the following processes and explain how it is retained.
 - filtration (2 marks)
 - reabsorption (2 marks)
 - release of ADH (2 marks)
- Explain how the term *homeostasis* applies to kidney function. Discuss two specific examples in your response which demonstrate the role of the kidney in maintaining homeostasis. (4 marks)
- Refer to the following chart.

SUBJECT	GLUCOSE IN URINE (%)	PROTEIN IN URINE (%)	URINE OUTPUT (L/day)
A (normal)	0.0	0.0	2.0
B	0.3	0.0	3.0
C	0.0	2.0	2.2
D	0.0	0.0	5.0

Diagnose the subjects with each of the following disorders and explain your answer:

- diabetes mellitus (2 marks)
- low ADH secretion (2 marks)
- abnormal functioning of Bowman's capsule (2 marks)

Reproduce the science skills assessment box after your response to this question. Remember to indicate your evaluation of your skill level for each identified science skill. Be sure to include the spaces for teacher assessment.

Self: A.	☐	B.	☐	C.	☐	D.	☐	E.	☐	F.	☐
Teacher: A.	☐	B.	☐	C.	☐	D.	☐	E.	☐	F.	☐

- Controlling the amount of water in your body is a critical role of the kidney. Explain how blood/water balance is regulated by the kidneys. (2 marks)

Science Skills

- ☐ A. Initiating
- ☐ B. Collecting
- ☐ C. Organizing
- ☒ D. Analysing
- ☒ E. Synthesizing
- ☐ F. Evaluating

5. Match the most correct part of kidney anatomy in Column I with its function from Column II. **(5 marks)**

Column I**Column II**

- | | |
|---------------|---|
| a. renal vein | i. filters the blood retaining large blood components only |
| b. nephron | ii. directs urine out of the body from the bladder |
| c. glomerulus | iii. carries purified blood away from the kidney |
| d. urethra | iv. filters blood, recovers vital components, and releases wastes |
| e. cortex | v. is the section of the kidney which holds nephrons |
6. Describe the principle behind the success of dialysis technology. **(2 marks)**
7. Explain how low and high blood pressure can contribute to kidney failure. **(2 marks)**
8. The following experiment was carried out by a Biology 20 student in the hopes of winning first prize in the Science Fair. Read the following summary of the experiment; then answer the questions. **(8 marks)**

Ten subjects consumed eight cups of coffee within an hour. A second group of ten subjects consumed eight cups of water within the same time period. The subjects were requested to collect and measure the amount of urine they produced.

- What is the hypothesis being tested by this student?
- Name four or more controls which should be in place in order to ensure that the experiment results are valid?
- Predict the expected results? Explain.

Science Skills

- ☐ A. Initiating
☐ B. Collecting
☐ C. Organizing
☐ D. Analysing
☒ E. Synthesizing
☒ F. Evaluating

Reproduce the science skills assessment box after your response to this question. Remember to indicate your evaluation of your skill level for each identified science skill. Be sure to include the spaces for teacher assessment.

Self: A.	☐	B.	☐	C.	☐	D.	☐	E.	☐	F.	☐
Teacher: A.	☐	B.	☐	C.	☐	D.	☐	E.	☐	F.	☐

9. The kidneys are not the only organs which play a role in excretion. Describe the excretory function of two other body organs. **(2 marks)**
10. The removal of urea is a critical function of the kidneys. Explain the origin of urea and the mechanism by which the kidneys ensure its secretion. **(3 marks)**

MODULE SUMMARY

This module has taken you on a journey through two major body systems – the circulatory and the excretory system. You have become aware of the unique structures within each system. Most importantly, you should have an appreciation of the interconnections that exist between these systems and all other body systems. As you have discovered, maintaining these interconnections is essential if internal homeostasis is to be achieved.

In the same way that you fit into nature's interconnected web of life, your body systems interconnect to give you life. In both scenarios the constant struggle for homeostasis is never ending. And, in both scenarios, your survival depends on it.

To ensure that all of your work has been completed in a satisfactory manner, check off the items in the following list:

- ☐ Section 1 Assignment has been completed.
- ☐ Section 2 Assignment has been completed.
- ☐ Section 3 Assignment has been completed.
- ☐ Your responses are organized and neat, with room for teacher comments.
- ☐ All your response pages are numbered consecutively and identified with this heading.

Biology 20 – Module 7	Section #	Assignment	Page #	Name and ID #
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COURSE SURVEY FOR BIOLOGY 20

Please evaluate this course and return this survey when you have completed your last module assignment. This is a course designed in a new distance-learning format, so we are interested in your responses. Your constructive comments will be greatly appreciated so that a future revision may incorporate any necessary improvements.

Name _____ Course _____

Address _____ Age ☐ under 19 ☐ 19 to 40 ☐ over 40

_____ File No. _____

_____ Date _____

Design

1. This course contains a series of Module Booklets. Do you like the idea of separate booklets?

2. Have you ever enrolled in a correspondence course before that arrived as one large volume?

☐ Yes ☐ No If yes, which style do you prefer?

3. The Module Booklets contained a variety of self-assessed activities. Did you find it helpful to be able to check your work and have immediate feedback?

☐ Yes ☐ No If yes, explain.

4. Were the questions and directions easy to understand?

☐ Yes ☐ No If no, explain.

5. Each section contains Follow-up Activities. Which type of Follow-up Activity did you choose?

- ☐ mainly Extra Help
- ☐ a variety
- ☐ mainly Enrichment
- ☐ none

Did you find these activities beneficial?

- ☐ Yes ☐ No If no, explain.

6. Did you understand what was expected in the section assignments?

- ☐ Yes ☐ No If no, explain.

7. The course materials were designed to be completed by students working independently at a distance. Were you always aware of what you had to do?

- ☐ Yes ☐ No If no, provide details.

8. Suggestions for audiocassette and videocassette activities are included in the course. Were you able to use these media options?

- ☐ Yes ☐ No Comment on the lines below.

Course Content

1. What is your overall impression of the course? Did it meet your expectations?

2. Did you find the work load reasonable?

☐ Yes ☐ No If no, explain.

3. Did you have any difficulty with the reading level?

☐ Yes ☐ No Please comment.

4. How would you assess your general reading level?

☐ poor reader ☐ average reader ☐ good reader

5. Was the material presented clearly and with sufficient depth?

☐ Yes ☐ No If no, explain.

General

1. What did you like least about the course?

2. What did you like most about the course?

Additional Comments

Only students enrolled with the Alberta Distance Learning Centre need to complete the remaining questions.

1. Did you contact Alberta Distance Learning Centre for help or information while doing your course?

☐ Yes ☐ No If yes, approximately how many times? _____

Did you find the staff helpful?

☐ Yes ☐ No If no, explain.

2. Were you able to fax any of your assignment response pages?

☐ Yes ☐ No If yes, comment on the value of being able to do this.

3. If you were mailing your assignment response pages, how long was it taking for their return?

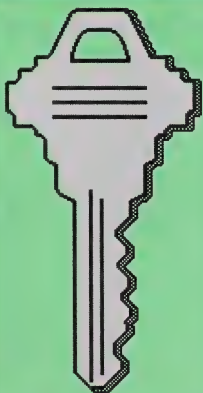
4. Was the feedback you received from your correspondence teacher helpful?

☐ Yes ☐ No Please comment.

Thanks for taking the time to complete this survey. Your feedback is important to us. Please return this survey with your last module assignment.

Instructional Design and Development Unit
Alberta Distance Learning Centre
Box 4000
Barrhead, Alberta
T0G 2P0

Appendix



Glossary

Activities

Extra Help

Enrichment

Glossary

ADH: antidiuretic hormone

dermis: inner layer of skin

edema: movement of water out of capillaries and into body tissues

epidermis: outer layer of skin

homeostasis: adjustments made by the body systems to maintain a steady internal set of conditions

homeogenous: consisting of the same components throughout

osmoregulation: maintaining a water balance in the body

pathogen: microorganism that can cause disease

Suggested Answers

Section 1: Activity 1

1. In multicellular organisms, millions of body cells are not directly exposed to their external environment. These internal cells are dependent on a circulatory system to connect them with the environment by supplying nutrients and oxygen and by carrying away their metabolic wastes.
2. The heart serves as a pump. The right ventricle pumps blood to the lungs where oxygen is taken up. The left ventricle pumps the oxygen-rich blood to the body cells.

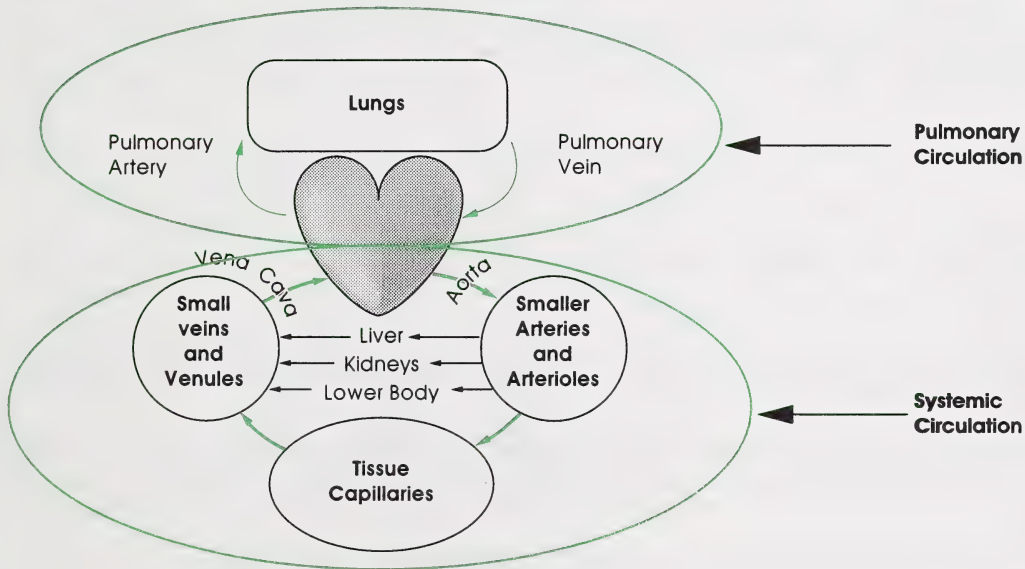
3.

	STRUCTURE	FUNCTION
Arteries	• thick walls – three layers include muscle and connective tissue • no valves	• carry blood away from the heart
Veins	• thin wall of smooth muscle • valves	• carry blood towards the heart • one-way valves open towards heart only
Capillaries	• tiny blood vessels • walls only one-cell thick	• is the site of exchange of O_2, CO_2, H_2O, nutrients, and wastes between blood and body cells

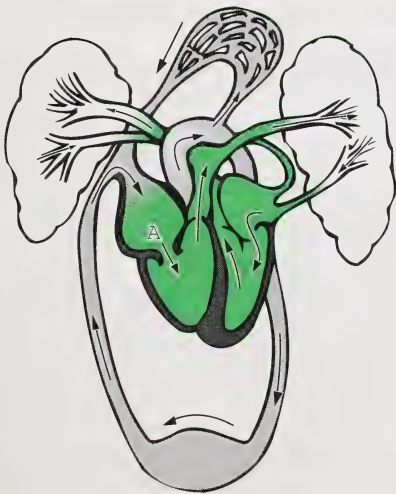
4. A pulse is the sudden expansion of an artery caused by blood pumped from the heart. It can only be felt in arteries that are close to the skin surface, for example, at your neck or wrist. The artery expands suddenly from a surge of blood. Each surge represents one contraction of the heart. Pulse can indicate the frequency and strength of a heart beat.
5. Blood flow in the veins is dependent upon the contraction of skeletal muscles. If a person is standing for long periods of time or has a genetic predisposition to faulty vein valves or weak muscle walls in their veins, a pool of blood can collect in the veins damaging the one-way valves. The veins stretch and become enlarged, a condition that is termed varicose veins.

6. Blood entering the right side of the heart is low in oxygen and high in carbon dioxide. This blood comes from the body cells. The right ventricle pumps this blood to the lungs. Blood entering the left side is oxygen rich as it is coming from the lungs. This blood will be pumped to the body cells by the left ventricle, leaving the heart through the main aorta.
7. The circulatory system supplies blood to the lungs where gas exchange takes place. Oxygen diffuses into the capillaries of the microscopic alveoli and carbon dioxide diffuses out. This exchange ensures that blood leaving the lungs and going back to the heart is rich in oxygen. The respiratory and circulatory systems are partners in supplying the body cells with oxygen and in removing carbon dioxide and water. The two systems also regulate body temperature by conserving or dissipating body heat.

8.



9.



10. From the main aorta blood passes through the following structures:

main aorta → arteries → capillaries → veins → vena cava → right atrium → right ventricle → pulmonary artery → lungs → pulmonary vein → left atrium → left ventricle → main aorta

Section 1: Activity 2

1. Twenty-one liquid crystals are embedded in the strip. Each one is sensitive to a particular temperature.
2. Ten seconds may be needed to reach a final temperature.
3. Orange-brown indicates a final specific temperature.
4. Green-blue indicates a half degree.
5. Violet-blue indicates nearly the next degree.
6. Room temperature is usually around 22°C.
7. Your skin temperature is likely not within the 20°C to 26°C range.
8. The back of your hand is likely around 33°C.
9. Your upper arm is closer to your body core and has larger muscles and blood vessels. This will give it a slightly higher temperature, perhaps 34°C.
10. The large amount of blood pumped to your head might give your forehead a temperature of 34 or 35°C.
11. Areas away from the core will be cooler as the peripheral circulation loses heat to the environment.
12. The peripheral circulation would reflect the increase in temperature.
13.
 - a. Arteriole diameter would increase to carry more blood and more heat away from the body core.
 - b. Greater arteriole blood flow is followed by greater capillary blood flow and thus increases the amount of heat that can radiate away from the body. This attempts to moderate rising body temperature. Greater peripheral blood flow causes the flushed appearance common in high fever. Perspiration may increase and with subsequent evaporation causes chills (further reducing temperature.) Have you had any of this happen to you?
14. To prevent heat loss, peripheral blood flow may be reduced in cold water.
15. If too much heat is lost from peripheral circulation, blood returning to the body core is cold and the core temperature may start to decrease. Hypothermia may develop if this condition continues unchecked.

Section 1: Activity 3

1. Valves in the heart ensure that blood only flows in one direction.

2. The coronary arteries deliver blood to the heart.
3.
 - a. The “lubb” sound occurs as the ventricles contract and blood is slapped back against the A/V valves. The blood pressure in the ventricles drop as they fill with blood. The higher volume of blood in the pulmonary artery and the aorta forces the semi-lunar valves to slap shut creating the “dubb” sound.
 - b. A heart murmur indicates a decrease in the efficiency of the heart. Instead of driving blood continually forward, a leaky valve allows blood to backflow through the valve. Cardiac output is reduced. The child could become exhausted early during physical activity due to the inefficient delivery of oxygen and nutrients to muscle cells.
4. While cardiac output is the same for the left and right ventricles, the left ventricle must pump blood a much greater distance through the body. The right ventricle only pumps blood to the lungs. Consequently the left ventricle is surrounded by a much larger mass of cardiac muscle than the right ventricle and therefore appears larger.
5. Cardiac output is calculated by using heart rate times stroke volume. Basically this is a calculation of how much and how fast blood is pumped.
6. Cardiac output indicates how hard the heart is working to meet the needs of the body. If it is in good physical condition, the heart will not have to work as hard to supply enough blood to the body. This reduces the strain on the heart.
7. Lee is probably in better physical condition than Tom because Lee’s heart can pump the same amount of blood per minute with fewer beats. Lee’s heart has a higher stroke volume (100 mL/beat compared to 50 mL/beat.)
8. As the person begins exercising, his or her heart rate increases. Cardiac output is the volume of blood pumped by the left ventricle per minute. A high heart rate will result in an increased volume of blood leaving the left ventricle per minute.
9. The following is an example of the maximum exercising heart rate for a twenty-year old:

$$200 - 20 = 180 \text{ beats per minute}$$
10. The following is an example of the Target Zone range for a twenty-year old:

$$\text{Lower limit} = 0.75 \times 180 = 135 \text{ beats/min} \qquad \text{Upper limit} = 0.85 \times 180 = 153 \text{ beats/min}$$
11. You will recall from studying cellular respiration that working body cells require large quantities of ATP. With vigorous exercise your contracting muscle cells are demanding large supplies of oxygen and nutrients to enable them to produce ATP. It is critical that your heart rate responds to metabolic cues in order to increase its pace to speed up the delivery of supplies to the working muscle cells. If your heart rate did not respond to the increased blood carbon dioxide level and increased blood acidity produced by the contracting muscles, the demand for ATP would be greater than the supply. Metabolic wastes would build up, thus initiating the onset of muscle fatigue which could result in death. As well as pumping more blood to the body cells, your heart must pump more blood to the lungs to pick up oxygen and release carbon dioxide and water.
12. Performing five trials should give you a more accurate resting heart rate. A single trial may give you an inaccurate reading, either higher or lower than normal.

13. Generally, the better your general fitness level, the lower your heart rate. Exercise increases the strength of the muscles of the heart which means that the heart can pump more blood with less effort with each contraction. A stronger heart means a lower resting heart rate since fewer beats are needed to circulate the same amount of blood.
14. Your resting heart rate should decrease. When you exercise and get stronger, your heart also works harder and gets stronger. A stronger heart is more efficient and fewer beats per minute are needed.
15. Strenuous exercise, such as the step test, produces other changes in body functions. Your working muscles produce heat which must be eliminated. Sweating is one way of reducing the body temperature as the evaporation of sweat cools the skin. Blood vessels also dilate on the skin surface to assist in heat exchange with the outside environment (hence the red face). Your muscles consume oxygen from the blood and contribute carbon dioxide. The increase in carbon dioxide stimulates breathing. This increased breathing allows more oxygen to diffuse into the blood. If you have eaten a full meal before exercising, you'll notice that you might suffer indigestion as the demand for blood by the muscle cells is so high that digestion shuts down.
16. Systolic pressure is the pressure exerted by blood in the arteries with ventricular contraction. Diastolic pressure is the pressure exerted by blood in the arteries between ventricular contractions (as the ventricles are filling with blood from the atria).

Example: 120 (systolic)/70 (diastolic) mm Hg

17. High blood pressure can cause small arteries to rupture. Hypertension also increases the risk of narrowing arteries by increasing the rate at which fatty plaque is deposited inside their walls. This increase in plaque (atherosclerosis) can eventually completely block an artery or can increase the risk of blood clot formation. The moving blood clot could lodge in a small blood vessel, blocking blood delivery. The results could be fatal. The most severe locations would be in the brain (stroke), the heart (heart attack), or kidney (kidney failure).
18. The blood pressure reads 120/80; e.g., the systolic pressure is 120 mm Hg and the diastolic pressure is 80 mm Hg.
19. There are some risk factors for heart disease that cannot be changed – age, family history, and sex. However, there are lifestyle factors which could effectively reduce your risk of dying of heart disease. These factors could include reducing stress, adjusting your diet to reduce fat and cholesterol intake, not smoking, maintaining normal weight, and increasing your activity level.

Follow-up Activities

Extra Help

1. The heart is a special pump. It consists of **four** chambers – two small upper **atria** and two large **ventricles**. The **right** ventricle delivers blood to the lungs and the **left** ventricle delivers blood to the entire body. The **valves** in the heart prevent the backflow of blood into the chambers.

Arteries are thickly walled and carry blood **away from** the heart. Veins are **thinly walled**. Special one-way valves ensure blood moves **towards** the heart when squeezed by surrounding muscles. **Capillaries** are microscopic blood vessels with walls that are only **one** cell thick. Through the thin capillary walls oxygen and nutrients diffuse to the body cells.

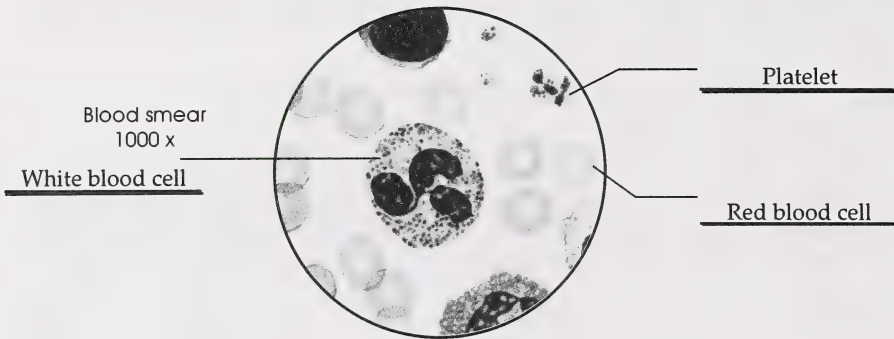
2. a. artery b. capillary c. artery d. vein
3. a. vi b. v c. ii d. vii e. i f. iv g. iii

Enrichment

1.
 - a. You should hear the two distinct heartbeats – lubb and dubb.
 - b. You normally can't hear blood at your pulse zones. The reason the sphygmomanometer enables blood to be heard is because the arteries are constricted by the arm cuff. The friction between the blood and the arterial wall as the blood is forced through by the heart can then be heard.
 - c. You should be able to hear amplified sounds in this activity.
 - d. This is difficult, but by listening carefully you should be able to hear the air entering the lungs.
 - e. You should hear the distinct rumblings of digestive activity.
 - f. Amplified sounds of the joint cartilage of the major jaw bones rubbing against each other can be heard.
2. The metabolism (hence the heart rate) of small animals is extremely high. Due to their small surface area to volume ratio, they are vulnerable to body heat loss to the environment. (Recall your work on surface area to volume ratio in Science 10).
3. Severe exposure to cold can cause the body to be unable to maintain adequate warming blood to its core. As the brain cools its mechanism to control blood supply, volume becomes impaired (as do other brain functions often causing disorientation, desire to sleep, etc.). Control of the peripheral circulation is lost and blood becomes spread out throughout the body. This increases the rate at which the body core temperature drops and hypothermia can set in. People can die within a short period of time from hypothermia if they are not rescued.
4. The metabolic rate of growing cancer tumours is very high. As the demand for oxygen and nutrients increases, the blood supply to the cancer cells must increase. This creates a "hot spot" which can be detected with the new research technique called thermography. By detecting "hot spots" with this technology, cancerous tumours can be detected. Such early detection improves survival rate as treatment can begin immediately.
5. Submersion in ice water drops body metabolism dramatically. The lowered metabolism reduces the requirement for both oxygen and nutrients by all body cells. Peripheral circulation is shut down, and to help the situation, the cooling of the internal organs including the heart and brain reduces their oxygen requirement. As a result these children can often recover without brain damage.

Section 2: Activity 1

1.



- a. Red blood cells (RBCs/erythrocytes): RBCs function in transporting O_2 . An iron-containing pigment called hemoglobin is found in RBCs and picks up the oxygen. RBCs cannot move independently and must be carried by the plasma. They outnumber WBCs approximately 700:1. They do not contain a nucleus; therefore, they cannot reproduce. RBCs function for approximately three months prior to being destroyed by the liver.
 - b. White blood cells (WBCs/leukocytes): WBCs are the body's defenders. They have independent locomotion and move like an amoeba toward a site of infection through capillary walls. Pus consists of living and dead bacteria and white blood cells. WBCs have a nucleus and can, therefore, reproduce in the bloodstream. Uncontrollable reproduction of WBCs causes a type of cancer of the blood called leukemia.
 - c. Platelets (thrombocytes): Platelets are cell fragments which function in the blood-clotting process. They contain proteins that cause blood to clot when they are torn open, for example on the rough edges of a wound.
2. Plasma makes up 55% of the blood. Plasma is approximately 90% water. It also consists of blood proteins, glucose, vitamins, minerals, dissolved gases, and waste products of cell metabolism.
 3. Red blood cells are able to carry more hemoglobin because they do not have a nucleus. This enables them to transport more oxygen. However, because RBCs are missing a nucleus they are incapable of reproducing inside the bloodstream.
 4. Sam's blood test would have revealed a low red blood cell number (iron deficiency). This factor would have reduced his ability to transport oxygen, resulting in anemia. The fact that less of his blood is oxygenated would result in his pale appearance. Blood turns bright red when it is fully oxygenated. His muscles would be receiving less oxygen which contributes to his fatigue.
 5. A lowered blood oxygen level increases RBC production by the bone marrow. This increase in transport vehicles ensures that adequate oxygen is delivered to demanding cells. Internal homeostasis is thereby maintained.
 6. All blood cells are produced in the bone marrow by specialized cells called stem cells.
 7. Red blood cells are in the highest proportion (5 million in one drop of blood). There are 700 RBCs to 1 WBC.

8. The biconcave shape increases the surface area for oxygen transport.
9.
 - a. A person with anemia would feel very tired as they have an inadequate number of red blood cells to supply their body cells with the oxygen they require.
 - b. The production of RBCs by the bone marrow is geared to oxygen levels. A low oxygen concentration causes the kidneys to release a factor which stimulates RBC production by the bone marrow. By increasing the number of red blood cells carrying oxygen, the body cells receive a sufficient oxygen supply. The person would begin to feel less tired.

Section 2: Activity 2

1. Lymph is the clear liquid continually lost by leakage from your capillaries. It is similar in composition to plasma. (Recall from your digestion studies the discussion of the tiny lacteals that function in picking up absorbed fat molecules). It is picked up by a system of blood vessels which run parallel to the circulatory system. Notice Figure 10.27 on page 266.
2. Lymph nodes are enlargements of the tiny lymph vessels called lymphatics. They harbour specialized white blood cells called lymphocytes that attack and kill bacteria.
3. The body's first line of defence against pathogens includes the skin, which is often termed the integumentary system, and the mucus lining of the respiratory and digestive system. The first line also includes the chemical protection which is provided by strong acid in the stomach.
4. In the second line of defence the white blood cells or leukocytes spring into action. They engulf the intruding microorganisms by phagocytosis (macrophages), produce antibodies (B cells), and inject the pathogens with toxic chemicals (killer T cells). The specialized white blood cells called helper T cells mobilize the B cells and killer T cells into action.
5. The Y-shaped protein of antibodies are designed to attach to invading organisms. The outer edge of each Y varies for each invading organism and can only attach to the invader's membrane with its specific antigen. Each antibody will only attach to one kind of antigen.
6. The following are the four lines of defence.

a. Skin provides the first protective barrier.	c. Antibodies are produced.
b. Macrophage engulf bacteria.	d. Killer Ts destroy remaining bacteria.
7.
 - a. Jenner observed that rural dwellers seemed less susceptible to smallpox than people living in cities.
 - b. He hypothesised that the injection with cowpox would provide protection from smallpox.
 - c. He injected a young person with cowpox. Then two months later he inoculated the person with smallpox virus. No disease resulted.
 - d. Infection with cowpox created immunity to smallpox.
8. Rabies vaccine and polio vaccine have been developed and have saved many lives.

9. Monoclonal antibodies that are specific to the cancer cell antigens could be grown. By incorporating toxic chemicals into the antibody they would effectively target and kill only the specific cancer cells. This would prevent the death of normal fast-growing cells which occur with general chemotherapy. Many of the side effects associated with general chemotherapy would be prevented, e.g., loss of hair, vomiting due to the breakdown of mucus lining of digestive tract, etc.
10. HIV attacks and enters the helper T cells of your immune system. The helper Ts mobilize the main immune response. Because they are attacked, the helper Ts are unable to mobilize the immune system. As a result it's very difficult to stop this virus. The impaired immune system begins to allow many other pathogens into the body which normally can be stopped. Therefore, people who develop full-blown AIDS die of illnesses which could have easily been combatted if their immune system was healthy.
11. You have special lymphocytes that act as memory cells after an invading organism has entered your body. They quickly mobilize antibody-producing B cells and the revisiting invader is stopped before you get sick again.
12. Lifestyle habits to build a stronger immune system include a well-balanced diet, regular exercise to help reduce stress, plenty of rest, and good hygiene.

Section 2: Activity 3

1. Excessive amounts of cold water could bring on hypothermia and increase the risk of cardiac arrest.
2. Pulling the material away could create an open wound and increase the risk of infection. Also, bleeding could increase as the skin might be pulled away with the material. The loss of blood could contribute to the risk of entering shock.
3.
 - a. The fluid that surrounds capillaries and body cells is called extracellular fluid or ECF.
 - b. The two forces that maintain the fluid level in the blood by regulating the movement of water between the ECF and the blood are blood pressure and osmotic pressure. The arteriole end of the capillary has a higher blood pressure than the venous end which forces water out into the ECF. The loss of water from the capillary increases the concentration of plasma proteins and ions (solute) in the venous end. This creates a solute concentration imbalance between the ECF and the blood. Recall from Science 10 that such an imbalance will result in the movement of water by osmosis into the area of high solute concentration. In this case, water moves by osmosis from the ECF into the venous end of the capillary. That is, osmotic pressure is high at the venous end of the capillary. The movement of water out of the capillary by the force of blood pressure and back into the capillary by osmotic pressure ensures that the fluid balance of the blood is maintained.
4. As soon as plasma proteins, salt, and other solutes begin leaking into the ECF, the osmotic pressure of the capillary is reduced. Water moves by osmosis into the ECF following the new concentration gradient. The homeostatic mechanism which normally causes water to move back into the capillaries is disrupted. The result is tissue swelling or edema. As the blood fluid volume drops, Susan could go into shock.
5.
 - a. Susan's total body surface burn is $2\% + 9\% + 4\% + 9\% + 3\% = 27\%$.
 - b. $4 \text{ cc/kg} \times 27\% \times 60 \text{ kg} = 64.8 \text{ cc}$

6. As water is drawn from the blood to the tissue spaces, the blood fluid volume drops. This causes the person's blood pressure to drop drastically. A low blood pressure means the cells are receiving inadequate amounts of nutrients and oxygen. The low blood pressure affects kidney function. Less urine is produced which means that cell wastes are accumulating. If blood supply to the brain is reduced, the person could go into shock which could be fatal.
7. The dermis layer contains the following structures: hair follicles and root; heat, pain, cold, and pressure sensors; oil glands; sweat glands; capillaries; and the arrector muscle (gives you goose bumps to make hairs on your body stand up when you're cold).
8. Susan had damage to the epidermis and to the dermis. The area requiring the graft had substantial damage to the dermis. It would take approximately twenty-one days for her skin to heal.
9. Section A: The initial increase in WBC count is due to the immune system becoming activated after the burn in an attempt to remove dead and dying skin cells and to combat bacteria.

Section B: The WBCs have been depleted due to the initial high demand for their action. This is a high risk time for infection if medical intervention isn't possible.

Section C: The WBC count is recovering as the burned area is healing.

Follow-up Activities

Extra Help

1. 
 - a. Red blood cells carry oxygen.
 - b. White blood cells fight infection and create immunity.
 - c. Platelets aid in blood clotting.

2. The first line of defence is primarily a physical barrier which is represented by the integumentary system. This system involves the skin and mucus lining. The skin offers an impermeable barrier to intruding pathogens. The mucus which is secreted by the lining of the respiratory system continually traps pathogens and the cilia move them up and out of your body. (Coughing effectively propels them far from your body.) In addition, your stomach offers chemical protection as the acidic content effectively destroys most microbes.
3. a. iii b. i c. ii d. iv
4. The volume of the organism will decrease. Water will move by osmosis out of the organism into the highly concentrated salt solution that surrounds it.

Enrichment

1. Blood types are A, B, AB, O, and also Rh+ or Rh-.
2. Hemophiliacs require specific blood factors, Factor 8 or 9, to enable their blood to clot. This factor is isolated by the Red Cross from whole blood received by blood donors. Approximately 100 units of Factor 8 are isolated from 1 unit of donated blood (450 mL). A 60 kg person with hemophilia requires approximately 1500 units of Factor B for one treatment. Considering that injections generally consist of three treatments per week, approximately 45 donated units are required for that one person per week.
3. Note that blood does much more than just carry oxygen.
4. Individuals with blood type A have the special antigen marker called A on their red blood cells. If recipients have type B blood, their RBCs will have B antigen and **antibody A** in their plasma; they would not be able to receive type A blood. Their antibodies would attack it. Recipients with blood type A and AB do not have antibody A in their plasma or they would reject their own blood. Therefore these people will accept a transfusion of blood with the blood type A antigen.
5.
 - a. An individual's blood type is identified by the antigen carried on their red blood cells (RBCs). For example, people with blood type A have antigen A on their RBCs and antibody B in their plasma. The blood on the slide agglutinated (clotted) with blood plasma from type A blood which contains antibody B. The incoming antigen must have matched antibody B for it to clot; therefore it was from type B blood. This is confirmed as they did not clot in type B plasma.
 - b. Upon contact with torn blood vessels the platelets congregate to seal the cut site. The injured tissue releases a protein called thromboplastin. The thromboplastin combines with blood calcium to cause prothrombin (a plasma protein) to become thrombin. Thrombin breaks apart the huge fibrinogen molecule to form fibrin fibres. The fibrin creates a blood clot which appears red as the RBCs are trapped inside it.
6. Calcium plays a critical role in the blood clotting process. By removing calcium, the step to produce prothrombin is blocked. This ensures the donated blood will not clot in the bag.

Section 3: Activity 1

1. The three main roles of the kidneys are to balance blood pH, to maintain adequate internal water content, and to eliminate wastes.
2.
 - a. lungs: eliminate carbon dioxide, a product of cellular respiration
 - b. large intestine: removes indigestible food products
 - c. skin: excretes salt and water through the sweat glands
3. The amino acid molecule travels to the liver where its nitrogen-containing component is broken off to become ammonia. Ammonia is toxic to the body; it is combined in the liver with waste carbon dioxide to become a less toxic molecule called urea.

4.
 - a. main aorta
 - b. renal artery
 - c. renal vein
 - d. vena cava
 - e. ureter
 - f. urethra
 - g. Figure 13.3 depicts a male urinary system because the urethra is longer. Compare Figure 13.3 to Figure 13.2.
5. The renal cortex refers to the outer section of the kidney. The medulla is the middle tissue.
6. The renal artery directs blood **to** each kidney and the renal vein directs blood **away from** each kidney. The vessel carrying blood that has been purified by the kidney is the **renal vein**.
7.
 - a. Filtration, reabsorption, and secretion are the necessary functions of a nephron.
 - b. Filtration requires blood pressure.
 - c. Reabsorption and secretion require active transport.
8.
 - a. Initial filtration occurs when blood pressure forces fluid out of the **glomerulus** and into **Bowman's capsule**.
 - b. Blood enters the glomerulus through the **afferent arteriole** and leaves through the **efferent tubule**.
 - c. Normally, water, urea, salt, glucose, amino acids, and hydrogen ions pass into Bowman's capsule.
 - d. Plasma proteins, RBCs, and platelets stay in the blood in the glomerulus. These should not go into Bowman's capsule or be found in urine.
9.
 - a. Active transport and osmosis work together to cause reabsorption of water.
 - b. Na^+ , HCO_3^- , Cl^- , salt, glucose, and amino acids move back into the blood.
10. Since glucose, salts, amino acids, and water have been reabsorbed, all that should remain is urea.
11. Tubular secretion occurs between the blood and the distal tubule of the nephron. Nitrogen containing wastes, minerals, hydrogen ions, histamines, and some drugs move from the blood into the tubule for secretion.
12.
 - a. The dye with large molecules remained in the glomerulus.
 - b. The dye with small molecules passed through the glomerulus to the nephron.
13. The dye disappeared from the cortex; then it reappeared.
14. Large molecules cannot filter through the glomerulus into Bowman's capsule. They stay in the blood and return to the body.
15. The nephron dips into the medulla. As the dye flowed down into the loop of Henle, it disappeared from the cortex for a short period. It then reappeared in the distal tubule which is located in the cortex.

16. Blood cells should not filter through the glomerulus as they are far too large. Blood cells in the urine would indicate the possibility of kidney disease.
17. Protein, possibly glucose, and substance X were not filtered into the nephron. They appear to have remained in the glomerulus.
18. Glucose is a small molecule and is therefore able to pass through the glomerulus into Bowman's capsule. If the lab was repeated, glucose should be in high concentrations in the capsule but would go back down to "0" in the loop of Henle. Glucose is actively reabsorbed by the proximal tubular cells; therefore it would register "0" in the loop of Henle and the collecting duct.
19. After filtration, water is reabsorbed into the blood increasing the concentration of urea and ammonia left in the tubule.
20. Water will always decrease in percentage by the end of the nephron as it is essential to the body; 99% is reabsorbed into the blood.
21. Substance X could represent red blood cells, white blood cells, platelets, or large plasma proteins. These blood components are all too large to pass through the glomerulus.

Section 3: Activity 2

1. By the time the filtrate has left the proximal tubule, 80 to 85% of the water has returned to the blood.
2. The high sodium concentration in the medulla increases the absorption of water by passive osmosis from the nephron back into the bloodstream.
3.
 - a. As an individual becomes dehydrated through sweating, decreased water intake, fever, vomiting, diarrhea, or severe burns, the concentration of solute in their bloodstream increases. This concentration increase is detected by specialized brain cells in the hypothalamus which stimulates the pituitary gland to release ADH.
 - b. ADH increases the permeability of the nephron to water causing increased water reabsorption to the bloodstream and decreased urine production. ADH causes more water to move back into the blood.
 - c. Alcohol affects brain functioning as you may be well aware. The brain centre, called the hypothalamus, that secretes ADH is no exception. Its sensitivity to the osmotic pressure of the blood is impaired. As a result, less ADH is secreted resulting in less water reabsorption by the nephrons. Urine output increases. The reduction in the reabsorption of water causes increased thirst as the body has been dehydrated.

Caffeine also affects ADH secretion in a similar manner. However to complicate the situation, caffeine also acts as a stimulant. This means it increases your heart rate. An increased heart rate causes increased blood pressure which results in more blood flowing through the kidney. More filtrate passes through the glomerulus; therefore the urine production is higher.

4. Diabetes mellitus: A high blood sugar content in the urine is indicative of diabetes mellitus. The lack of insulin in the body causes high blood sugar levels. The nephric filtrate is overloaded with sugar and, despite maximum reabsorption by nephron cells, it is excreted. Diabetes mellitus occurs when the pancreas no longer produces insulin.

Diabetes insipidus: Urine output is extremely high. ADH production is impaired. The lack of ADH makes water reabsorption less efficient and large volumes of water are excreted. Normally you might pass 1 to 2 L per day. Urine output may be as high as 20 L per day.

Bright's disease or nephritis: Large molecules such as proteins are found in the urine. Blood vessels in the glomerulus break down destroying its filtering mechanism. Protein and red blood cells enter the nephron and are excreted in the urine.

5. Diabetes mellitus is indicated by glucose in the urine as in sample X. Sample Y contains ketones which also may indicate diabetes.
6. Diabetes insipidus is indicated by very dilute urine or urine with a low specific gravity (<1.010). This may not be evident in any of your samples.
7. Bright's disease is indicated by protein in the urine as in sample W. Sometimes the protein only shows up as a trace.
8. Sample Z is most normal.

Section 3: Activity 3

1. With renal failure many changes will occur that destroy the blood's homeostasis:
 - Urea will accumulate in the blood.
 - Blood pH becomes very acidic as hydrogen ions accumulate.
 - Sodium retention will result in water movement into tissues by osmosis causing edema throughout the body.
 - Other ions such as potassium accumulate.
 - Decreased RBC count due to loss of the hormone erythropoietin which is secreted by the kidney in response to low blood oxygen to trigger increased RBC production by the bone marrow.
2. The ions in the blood will diffuse into the dialysis fluid until the concentration in the blood equals the concentration of ions in the dialysate fluid.
3. A low fat and low salt diet will help reduce the risk of high blood pressure. A diet high in fat can increase the amount of cholesterol in your bloodstream. This can result in plaque buildup in your arteries which causes them to narrow – a condition called atherosclerosis. A narrow artery will result in higher blood pressure.

High salt intake will result in fluid retention which can increase blood pressure.

Increased aerobic exercise reduces the risk of cholesterol deposits forming in your arteries.

Section 3 Follow-up Activities

Extra Help

1. Renal artery

- red blood cells
 - platelets
- water
 - salt
- uric acid
 - glucose
- proteins
 - amino acids
- hydrogen ions
 - urea

Renal vein

- red blood cells
 - platelets
- glucose
 - proteins
- water
 - amino acids
- salt

Ureter

- water
- urea
- salt
- uric acid

2. a. Urea (also creatine and uric acid), a by-product of protein digestion, is secreted. It is poisonous to your body. Sodium is both secreted and reabsorbed at different locations as needed. Hydrogen ions are secreted to help maintain blood pH.
- b. Water moves passively by osmosis from areas of low sodium (high water) concentrations to areas of high sodium (low water) concentrations.

3.

								^a C											
								O							^b G				
								^c P	R	O	X	I	M	A	L				
								T							O				
^d H		^e H	Y	D	^f R	O	G	E	N						M				
Y					E			X		^g H	E	N	L	E					
P					A										R				
E					B					^h S	O	ⁱ D	I	U	M				
R			^j L		S							I		L					
T			I		O					^k U		A		^l U	R	E	A		
E			V		R					R		L		S					
N			E		P					I		Y							
^m S	E	C	R	E	T	I	O	N		N		S							
I					I					ⁿ P	E	R	I	T	O	N	E	U	M
O					O							S							
N					^o N	E	P	H	R	O	N								

Enrichment

1. Urine output is increased as a result of alcohol intake. This fact would help in voiding (excreting) kidney stones as the concentration inside the nephrons is reduced. However in the long term, alcohol lowers the water content in the blood causing dehydration as well as being toxic to liver and brain cells. It would be wiser to increase water intake to the suggested eight glasses a day to minimize the risk of kidney stones rather than increasing alcohol intake.
2. Information on dialysis may be available from your local clinic, nearby hospital, or the Kidney Foundation of Canada.
3. Write to the following:

Kidney Foundation of Canada
Edmonton Chapter
11574-149 Street
Edmonton, Alberta
T5M 1W7
4. Urine analysis is a routine medical test. You may find that initial analysis uses the same materials as you did in your module. Ask to see microscopic slides of urine constituents.
5. The Canadian Dental Association may have information on mercury amalgam fillings. Your dentist would have the address.



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